

THE  
ANATOMY  
OF THE  
HUMAN BONES, NERVES,  
AND  
LACTEAL SAC and DUCT.

The EIGHTH EDITION.

By ALEXANDER MONRO Senior, M. D. and  
F. R. S. Fellow of the Royal College of Physicians,  
and Professor of Medicine and Anatomy  
in the University of Edinburgh.

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M,DCC,LXVIII.



STUDENTS OF ANATOMY

IN THE

UNIVERSITY OF EDINBURGH

GENTLEMEN,

WHEN this Overture was first printed in 1776, I did not know that Albinus, Winslow, and others were to publish descriptions of bones; otherwise my paper would have been unnecessary. I have, however, in this Overture, endeavoured to assist my students by affording them to understand my terms and representation of things in this fundamental part of anatomy; and that it has possibly been of more advantage to them than a more complete work from an able hand, unless my demonstration had been in the order and method of such an author.

TO THE  
STUDENTS of ANATOMY  
IN THE  
University of EDINBURGH.

GENTLEMEN,

**W**HEN this *Osteology* was first printed in 1726, I did not know that Albinus, Winflow, and Palfyn, were to publish descriptions of the bones; otherwise my papers probably would have remained yet undelivered to the printers. I however flatter myself, that this *essay* has been of use to the gentlemen who did me the honour to attend my lectures, by assisting them to understand my sense and representation of things in this fundamental part of anatomy; and that it has possibly been of more advantage to them than a more compleat work from an abler hand, unless my demonstrations had been in the order and method of such an author.

This view of your improvement, Gentlemen, is a prevailing argument with me to cause this essay to be reprinted; and you cannot reasonably blame me, if I likewise acknowledge another motive for it, which more particularly relates to myself. In a new edition an author has an opportunity of making his works more correct, compleat, and consequently acceptable to the public, who may perhaps be indulgent enough to think this little treatise not altogether useless; since more reasoning on the structure and morbid *phenomena* of bones is to be found in it, than in the other writers, who have confined themselves almost entirely to the descriptive or proper anatomical part of the *osteology*.

I have here kept to the plan of the former editions, by first considering, in the order that seemed to me most natural and methodical, every thing which I thought necessary to be known concerning bones in general; and, in the second part, I have described the several bones composing the skeleton.

The

The bones of adults are what I principally endeavour to describe; but I have added as much of the *osteogenea* as I think serviceable in the practice of physic and surgery.

That little might be omitted of what was formerly done on this subject, I have taken all the assistance I could from books; but have never asserted any anatomical fact on their authority, without consulting nature, from which all the descriptions are made; and therefore the quotations from such books serve only to do justice to the authors, who have remarked any thing in the structure of the parts that was commonly omitted, and to initiate you in the history of anatomy; which I once proposed to make complete, so far as related to this subject: But not being able to procure several books, and being sensible how many more may have never come to my knowledge, I laid aside this design, of purpose omitted many I could have inserted, and in some places I have changed an older author for a later one, who has more fully or clearly described what I treated of. Beside anatomists, I have also named

med several other authors to confirm my reasoning by practical cases; of which it is not to be supposed my own experience could furnish a sufficient variety.

You will readily observe, that I quote no passages with a view to criticise or condemn them. This precaution of giving no offence, is very necessary in those who are sufficiently conscious of their being liable to lay themselves open to just censure; and it prevents occasions of useless wrangling, in which generally both parties are losers, and the public has little advantage.

In this treatise I always make use of the most common name of each part, and have put the synonymous names to be met with in books at the foot of the page, that the reading might be smoother, and you might consult them at your leisure to assist you in understanding different authors.

The descriptions and reasoning are here blended, without which I always find young anatomists are soon disgusted with authors: Their imaginations cannot follow a long chain of descriptions, especially when they are not taught



taught at the same time the uses which the described parts serve: Their minds must have some relaxation, by a mixture of reasoning, which never misses to strike the fancy agreeably, and raises a strong desire to understand the principles on which it depends.

The *phenomena* of diseases are all deduced in this essay from the structure of the parts, by way of corollaries and questions; which such an anatomical work confined me to: And this method has otherwise a good effect: For, when one meets with an useful proposition, and is obliged to employ a little thought to find out its solution, the impression it makes is deeper, and he acquires a fondness for it, as being in part his own discovery. My pupils have frequently assured me, that they could, with very small reflection, trace out the whole reasoning from which my conclusions were drawn; I hope their successors will also think this an agreeable manner of being instructed.

Those gentlemen who desired I would add the lectures which I pronounce in my colleges as a commentary upon the text, where the diseases are mentioned,

ed, will, I persuade myself, excuse me for not complying with their desire, when they consider the design of this is to be a school-book, and how great the difference is between instructing youth in private, and pretending to inform the public. *Art. xxiv. vol. v. of Medical Essays and Observations*, published in this place, is one of these lectures which I gave as a commentary on the paragraph (*p. 12.*) concerning the different kinds of *caries*.

In this edition, I have corrected the mistakes and obscure passages which I discovered in the former, and in some places I have made the descriptions more full and exact, aiming all I could to shun unnecessary minuteness on the one hand, and a blameable inaccuracy on the other: Whether I have hit that just medium, is what you and the public must now judge.

I am still of opinion, that figures of the bones would at any rate have been unnecessary in a book that is intended to be illustrated and explained by the originals themselves; but would be much more so now, when my late ingenious friend Mr Cheselden, Dr Albinus,

mus, and Mr Sue (a), have published such elegant ones.

You have advantageous opportunities in this place of studying all parts of medicine, under the professors of its different branches in the University, and of seeing the practice of pharmacy, surgery, and physic, with our surgeon-apothecaries, and in the Royal infirmary, where the diseased poor are carefully treated. These your interest, and, I hope, your inclinations, will lead you, Gentlemen, so to improve, as that they may become the happy means of your making a considerable figure in your several stations. Whatever assistance is in my power towards such a desirable event, shall be given with the greatest pleasure by

Your humble servant,

ALEX<sup>R</sup>. MONRO.

(a) Traité d'osteologie, traduit de l'Anglois  
de M. MONRO, seconde partie.

and the right lung is the largest.

The coats of the lung and chest are thin and  
 are composed of the following layers: from the inside of which  
 the lung, small terminal vessels are produced  
 and most commonly in pairs; which are so  
 placed as to allow the passage of lymph up  
 and down the chest, but opposite their roots in an opposite  
 direction. The number of these is generally ten.

This is the most simple and common course,  
 and the structure of the respiratory  
 apparatus is such, but having had occasion  
 to observe a variety in these parts, of different  
 kinds, I shall now show the most common.

The most common is that in which the  
 vessels are arranged in a spiral form, and  
 in the former disposition; is not always  
 of the same dimensions; is not composed of  
 a large number of ducts, and is generally  
 composed of several small ducts or tubes.

The diameter of the duct is very small,  
 and is seldom uniform in the same  
 duct; but frequently, indeed, enlargements or  
 swellings of it are observable. The ducts  
 which authors mention of the lung are very  
 numerous. I have seen it divided into  
 three, one branch extended over the  
 rest of the lung at the eighth vertebra  
 of the neck, and at the fifth ribbed behind that  
 to join the other branch which comes  
 to the ordinary course. The rest of the

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THE  
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HUMAN BONES.

PART I.

Of the BONES in general.

**B**ONES are covered by a membrane, named on that account PERIOSTEUM \*, which is so necessary to them, that we must examine its texture and uses, before we can understand their structure.

The *periosteum*, as well as most other membranes, can be divided into *layers* of fibres. The *exterior* ones, composed of the fibres of the muscles connected to the bones, vary in their number, size, and direction, and consequently occasion a very great difference in the thickness and strength of the *periosteum* of different bones, and even of the different parts of the same bone. The *internal* layer is every  
A where

\* Membrana circumossalis, omentum ossibus impositum.



## 2 OF THE BONES IN GENERAL.

where nearly of a similar structure; and has its fibres in the same direction with those of the bone to which they are contiguous. Ought not then the name *periosteum* to be applied, strictly speaking, only to this internal layer, to which the others are joined in an uncertain manner and number?

Some authors (a) endeavour to prove the internal layer of fibres of the *periosteum* to be derived from the *dura mater*: For, say they, since the membrane covering the skull is plainly a production or continuation of the *dura mater*, which passes out between the sutures; and since there are muscles on the head, as well as in other parts, which might furnish a *periosteum*, it is needless to assign different origins to membranes which have the same texture and uses. They add further, in proof of this doctrine, that the *periosteum* extends itself along the ligaments of the articulations from one bone to another; and therefore is continued from its origin over all the bones of the body.—While anatomists were fond of the hypothesis of all membranes being derived from one or other of the two that cover the brain, a dispute of this kind might be thought of consequence: But now that the hypothesis is neglected as useless, it is needless to examine the arguments for or against it.

Except where muscles, cartilages, or ligaments are inserted into the *periosteum*, its external surface is connected to the surrounding parts by thin cellular membranes, which can easily be stretched considerably, but shorten themselves whenever the stretching force is removed.

(a) Havers, *Osteolog. nov. disc.* 1. p. 16.

moved. When these membranes are cut off or broken, they collapse into such a small space, that the surface of the *periosteum* seems smooth and equal.

When we attempt to tear off the *periosteum* from bones, we see a great number of white threads produced from the membrane into them; and, after a successful injection of the arteries with a red liquor, numerous vessels are not only seen on the *periosteum* (a), but most of the fibres sent from the membrane to the bone, shew themselves to be vessels entering it, with the injected liquor in them; and when they are broken, by tearing off the *periosteum*, the surface of the bone is almost covered with red points.

The veins corresponding to these arteries are sometimes to be seen in subjects that die with their vessels full of blood; though such numerous ramifications of them, as of the arteries, can seldom be demonstrated, because few of them naturally contain coloured liquors, and such liquors can difficultly be injected into them. This however is sometimes done (b).

The great sensibility of the *periosteum* in the deep-seated species of *paronychia*, in *exostoses*, *nodi*, *tophi*, and *gummata*, from a *lues venerea*, or whenever this membrane is in an inflamed state, is a sufficient proof that it is well provided with nerves, though they are perhaps too small to be traced upon it; and therefore one

A 2

cannot

(a) Ruysch. Epist. 5. tab. 5. fig. 1. 2. epist. 8. tab. 9. fig. 19.

(b) Sue traité d'osteologie, traduit de l'Anglois de Mr Monro. Note in page 9.

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cannot well determine, whether they are sent along with the arteries in the common way, or are derived from the tendinous fibres of the muscles expanded on the *periosteum* (a).

Vessels also pass through the *periosteum* to the marrow; of which more hereafter. And frequently muscles, ligaments, or cartilages, pierce through the *periosteum*, to be inserted into the bones.

The chief uses of the *periosteum* are : 1. To allow the muscles, when they contract or are stretched, to move and slide easily upon the bones; the smooth surface of this membrane preventing any ill effects of their friction upon each other. 2. To keep in due order, and to support the vessels in their passage to the bones. 3. By being firmly braced on the bones, to assist in setting limits to their increase, and to check their overgrowth. 4. To strengthen the conjunction of the bones with their *epiphyses*, ligaments, and cartilages, which are easily separated in young creatures, when this membrane is taken away. 5. To afford convenient origin and insertion to several muscles which are fixed to this membrane. And, lastly, to warn us when any injury is offered to the parts it covers; which, being insensible, might otherwise be destroyed without our knowledge, or endeavouring to procure a remedy.

When

(a) See the dispute about the sensibility of this and of other membranes in Zimmerman. Dissert. de irritabilit. — Act. Gotting vol. 2 — Haller Sur la nature sensible et irritable. — Whytt's physilog. essay II. — Remar. Dissert. de fungo articular. § 26. 34.

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When the cellular substance connecting the *periosteum* to the surrounding parts is destroyed, these parts are fixed to that membrane, and lose the sliding motion they had upon it ; as we see daily in issues, or any other tedious suppurations near a bone.—When the vessels which go from the *periosteum* to the bones are broken or eroded, a collection of liquor is made between them, which produces a sordid ulcer or rotten bone. This often is the case after fractures of bones, and inflammations of the *periosteum*, or after *small-pox*, *measles*, *spotted fevers*, and *erysipelas*.—Do not the disorders of the *periosteum*, coming rather along with or soon after the cutaneous than other diseases, indicate some similarity of structure in the *periosteum* and skin ?

The BONES are the most hard and solid parts of the body, and, as all other parts where large vessels do not enter, are generally of a white colour ; only in a living creature they are blueish, which is owing to the blood in the small vessels under their surface. The less therefore and fewer the vessels are, and the thicker and firmer the bony surface covering the vessels is, the bones are whiter. Hence the bones of adults are whiter than those of children ; and, in both young and old, the white colour of different bones, or of the several parts of the same bone, is always in proportion to their vessels and solidities ; which circumstances ought to be regarded by surgeons, when they are to judge of the condition of bones laid bare.



## 6 OF THE BONES IN GENERAL.

Bones are composed of a great many *plates*\*, each of which is made up of fibres or strings united by smaller fibrils (a); which being irregularly disposed, and interwoven with the other larger fibres, make a reticular work. — This texture is plainly seen in the bones of fœtuses, which have not their parts closely compacted, and in the bones of adults which have been burnt, long exposed to the weather, or whose composition has been made loose by diseases. — The chinks which are generally made according to the direction of the larger fibres of bones that have undergone the action of fire, or of the weather, shew the greater strength of these than of the fibres which connect them. — Numerous accurate observations of the different times in which exfoliations are made from the sides or ends of similar bones, might bid fair to determine what is the proportional force of cohesion in the two sorts of fibres.

The plates are said (b) to be firmly joined to each other by a great number of *claviculi*, or small bony processes, which, rising from the inner plates, pierce through some, and are fixed into the more external ones. Of these nails, four kinds, viz. the *perpendicular*, *oblique*, *headed*, and *crooked*, have been described: But in bones fitly prepared, I could only see numerous irregular processes rising out from the plates (c).

Though the exterior part of bones is composed of firm compact plates, yet they are all more

\* Squamæ, bractææ, laminæ.

(a) Malpigh. Ana. plant. & oper. posthum.

(b) Gagliard. Anat. ossium. nov. invent. illustrat. cap. 1. obs. 2.

(c) Malpigh. oper. posthum.



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more or less cavernous internally. In some (*e. g.* middle thin part of the *scapula* and *os ilium*) the solid sides are brought so near, that little cavity can be seen; and in others (middle of *os humeri*, *femoris*, &c.) the cavities are so large, that such bones are generally esteemed to be hollow or fistular. But the internal spongy texture is evident in young animals; and some of it may be seen to remain in those of greatest age, when bones are cautiously opened, after they have been kept so long as to be free of the oil they contain, or after being burnt.

This spongy cavernous internal part of bones, is generally called their *cancelli* or LATTICE-WORK, and is formed in the following manner. The plates are firmly joined about the middle of the bone; but as they are extended towards its ends, the more internal plates separate from the exterior, and stretch out their fibres towards the axis of the bone, where they are interwoven with the fibres of other plates that have been sent off in the same way. Seeing the plates are thus constantly going off, the solid sides of the bones must become thinner, and the lattice-work must be thicker and stronger towards their ends. This is evident in many of them, where the solid sides of their middle are very thick, and the *cancelli* are scarce observable; whereas, at the ends, where their diameter is greatest, the solid walls or sides are not thicker than paper, and the *cancelli* are numerous and large enough to fill up the whole space left between the sides.

The twisting and windings which these *cancelli* make, and the interstices which they leave, differ

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differ considerably in figure, number, and size; and therefore form little cells, which are as different, but communicate with each other. Some writers (a) minutely remark these different appearances of the *cancelli*, after they begin to separate from the plates; and from thence distinguish them into *wrinkled*, *perforated*, and *net-like*.

The *cancelli* sustain the membranous bags of the marrow which are stretched upon them, and thereby hinder these membranous parts to be torn or removed out of their proper places, in the violent motions and different postures which the bones are employed in. This Support which the *cancelli* afford the marrow, also saves its membranes and vessels, in the lower parts of the bones, from being compressed by the weight of the marrow above.

The depressions between the fibres of the external plates of bones appear like so many furrows on their surface, into each of which the *periosteum* enters; by which the surface of contact, consequently the cohesion, between it and the bone, is considerably increased, and a greater number of vessels is sent from it into the bone, than if it was a plain surface.

Both on the ridges and furrows, numerous little pits or orifices of canals are to be seen, by which the vessels pass to and from the bones.

After a successful injection, the arteries can be traced in their course from the pits to the plates and fibres; and, in sawing, cutting, or rasping the bones of living creatures, these vessels discover themselves, by the small drops of blood

(a) Gagliard, Anat. ossium, cap. 1. obs. 4. 5. 6. 7.

blood which then ouze out from the most solid part of the bones. But the clearest demonstration of the intimate distribution of these small arteries, is, to observe the effect of such a tinging substance as can retain its colour, when swallowed, digested; and mixed with the blood of any living animal, and at the same time has particles small enough to be conveyed into the vessels of the bones; such is *rubia tinctorum*, madder-root (a): For we see the gradual advances which this tincture makes from the *perosteum* into the more internal parts of the bones, and how universally the distribution of the liquors is made, the whole bony substance being tinged. Whether the time in which this tinged liquor passes from the outer to the internal plates, till all the plates are made of its colour, and the time which the disappearing of the dye, after giving the creature no more of this sort of food, makes us think it takes to return, are the same in which the natural liquors circulate, is uncertain; because this tinging substance may move more slowly, or may pass more quickly, than the natural liquors do. — The arteries are larger near each end than at the middle of the large bones that are much moved; because they not only serve the bony plates near the ends, but pass through them to the marrow. — As animals advance in age, the arteries of the bones become less capacious; as is evident, 1. From the bones of adults having less blood in them than those of children have.

2. From

(a) Philosoph. transact. num. 442, art. 8. num. 443. 2. num. 457. art. 4. — Mem. de l'acad. des sciences. 39, 1742.

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2. From many of them becoming incapable in old age of admitting the coloured powders used in injections, which easily pass in youth. And,

3. From the bones of old creatures being more difficultly tinged with madder than those of young ones.—If authors have not mistaken, the arteries of bones have sometimes become very large (a).

We may conclude from arteries being accompanied with veins so far as we can trace them in every other part of the body, that there are also veins in the bones; and the disappearing of the tincture of *madder*, after bones of living animals are coloured with it, could not be without such veins to carry it away; nay, the veins of bones can sometimes be injected and then seen (b).

The bones of a living animal are so insensible, that they can be cut, rasped, or burnt, without putting the creature to pain, and the nerves distributed in their substance cannot be shewn by dissection; from which it might be inferred that they have no nerves distributed to them: But the general tenor of nature, which bestows nerves to all the other parts, should prevent our drawing such a conclusion. And if sensibility is a sure proof of nerves entering into the composition of any part, as it is generally allowed to be, we have sufficient evidence of nerves here in the bones; for the granulated red flesh which sprouts out from them, after an amputation of a limb, or performing the operation

(a) Diemerbroeck. Anat. lib. 9. cap. 1. — Mery. Hist. de l'acad. des sciences, 1704.

(b) Sue trad. d'osteolog, p. 9.



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operation of the *trepan*, or after an *exfoliation*, is exquisitely sensible: And, in some ulcers of bones, where the *periosteum* was all separated, the patient suffered racking pain, if the bone was touched with a rough instrument; or was he free of pain after the bone was perforated (a)——The reason why the nerves of rigid hard bones become insensible, is, That all nerves must have a considerable degree of flexibility at the part where objects are applied, otherwise it cannot be affected by their impressions. We see this illustrated in a very common analogous case, the growth of a new nail: When the former one has suppurated off, the thin membrane which first appears, is exquisitely sensible; but gradually becomes dull in its sensation, till it can be cut or scraped, without causing pain, after it is formed into a hard nail.

From what has been said of the vessels of bones, it is evident, that there is a constant circulation of fluids in every part of them; and that there is a perpetual waste and renewal of the particles which compose the solid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the waste during the growth of the bones; the renewal and waste keeping pretty near *par* in adult middle age; and the waste exceeding the supply from the liquors in old age; as is demonstrable from their weight: For each bone increases in weight, as a person approaches to maturity; continues of nearly the same weight till old age begins, and then becomes lighter.

—The specific gravity of the solid sides, on the

(a) Nicol, *Massa*, lib. introd, anat, cap. 30,



the contrary, increases by age ; for then they become more hard, compact, and dense. In consequence of this, the bones of old people are thinner and firmer in their sides, and have larger cavities than those of young persons.

The vascular texture of bones must make them subject to *obstructions*, *ecchymoses*, *ulcers*, *gangrenes*, and most other diseases which the softer parts are affected with ; and therefore there may be a greater variety of *caries* than is commonly described (*a*).

Hence we can account for the following appearances.

*Hæmorrhagies* from fungous flesh rising out from the most solid part of a cut bone (*b*).

The regular alternate elevation and subsiding, or apparent pulsation, frequently to be seen in some of the cells of a carious bone.

Cells resembling *cancelli*, sometimes seen in the part of a bone, which, in a natural state is the most solid and firm (*c*).

A bone as a tube including another bone within it (*d*).

On the internal surface of the solid parts of bones, there are orifices of canals, which pass outwards through the plates to open into other canals that are in a longitudinal direction, from which other *transverse* passages go out to terminate in other *longitudinal* canals ; and this structure is continued through the whole substance of bones, both these kinds of canals becoming smaller

(*a*) Edinburgh Medical essays and obs. vol. 5. art. 25.

(*b*) Medical essays, vol. 4. art. 21.

(*c*) Ruyfch Thes. 8. num. 8. Thes. 10. num. 176.

(*d*) Idem, *ibid*.

smaller gradually as they approach the outer surface (a).—These canals are to be seen to the best advantage in a bone burnt till it is white : When it is broken transversely, the orifices of the *longitudinal* canals are in view ; and when we separate the plates, the *transverse* ones are to be observed. Here however we are in danger of believing both these sorts of canals more numerous than they really are ; because the holes made by the processes connecting the plates of bones have the appearance of the *transverse* (b), and the passages for the blood-vessels resemble the *longitudinal* canals. I don't know how we are to keep free of error about the *transverse* canals ; but think we may distinguish between the two kinds of *longitudinal* ones ; for the passages of the vessels are largest near the external surface of the bone, and every transverse section of them is circular ; whereas the *longitudinal* canals are largest near the *cancelli*, and their transverse sections appear to me of a flat oval figure, which may be owing to the different *momentum* of the fluids conveyed in them.—The situation of the larger longitudinal canals, and of the passages of the larger vessels, makes a bone appear more dense and compact in the middle of its solid sides, than towards its outer and inner surfaces, where it is spongy.

We see marrow contained in the larger transverse and longitudinal canals just now described, and from thence judge that it passes

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also

(a) Havers Osteolog. nov. p. 43.

(b) Morgagn, Advers. 2. animad. 25.

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also into the smaller ones. The drops of oil which we discover with a microscope every where on the surface of a recent bone fractured transversely, and the ousing of oil through the most solid bones of a skeleton, which renders them greasy and yellow, are a confirmation of the use of these canals. Of what advantage this distribution of the marrow thro' the substance of bones is, will be mentioned when the nature and use of this animal oil is inquired into.

Most bones have one or more large oblique canals formed through their sides for the passage of the medullary vessels, which are to be described afterwards.

Bones exposed to a strong fire in chemical vessels, are resolved, in the same manner as the other parts of animals, into *phlegm*, *spirit*, *volatile salt*, *fetid oil*, and a black *caput mortuum*. But the proportion of these principles varies according to the age, solidities, and other circumstances of bones. Young bones yield the largest proportion of *phlegm*; spongy bones afford most *oil*, and solid ones give most salt and black *residuum*.—Though this *residuum* can scarce be changed by the force of fire while it is in close vessels; yet, when it is burnt in an open fire, the tenacious oil, to which it owes its black colour, is forced away, and a white earth is left that has little or no fixed salt in it. This earth seems to be the proper constituent solid part of bones, and the other principles give it firmness and tenacity: For the quantity of the earth is so great, that, after all the other principles

principles are separated from a bone, its former shape and size remain (*a*); but it is very brittle till it is moistened with water or oil, when it recovers some tenacity.—The increase of the proportion of earth in old people's bones is one reason of their being more brittle than those of young people are.

Let any imagine the salts and oils of bones, while in a natural state, to be of the same acrid kind with those obtained from them by the chemical analysis, it is to be observed, that these principles may be extracted from bones in the form of a very mild jelly, by boiling them in water.

The bones sustain and defend the other parts of the body.

Bones are lined within, as well as covered externally, with a membrane; which is therefore commonly called PERIOSTEUM INTERNUM.

The *internal periosteum* is an extremely fine membrane; nay frequently it has a loose reticular texture; and therefore it is compared by some to the *arachnoid* coat of the spinal marrow: so that we cannot expect to divide it into layers as we can divide the *external periosteum*. We can however observe its processes entering into the transverse pores of the bones, where probably they are continued to form the immediate canals for the marrow distributed through the substance of the bones; and along with them vessels are sent, as from the external *periosteum*, into the bone (*b*). These processes being of a very delicate texture, the adhesion

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of

(*a*) Havers Osteolog. nov. disc. 1. p. 33

(*b*) Winslow Exposition anat. des os frais, § 82. 83.



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of this membrane to the bone is so small, that it separates commonly more easily from the bone than from the marrow which it contains: Wherefore, one might call it the common membrane of the marrow, rather than by the name it now has. But whether one or t'other designation ought to be given it, is not worthy a dispute.

From the internal surface of the internal *periosteum*, a great number of thin membranes are produced; which, passing a-crofs the cavity, unite with others of the same kind, and form so many distinct bags, which communicate with each other; and these again are subdivided into communicating vesicular cells, in which the marrow is contained. Hence it is, that the marrow, when hardened, and viewed with a microscope, appears like a cluster of small pearl; and that the hardened marrow of bones buried long under ground, or laid some time in water, and then dried, is granulous (a). This texture is much the same with what obtains in the other cellular parts of the body, where fat is collected; only that the cells containing the marrow are smaller than those of the *tunica adiposa* or *cellulosa* elsewhere, which probably is owing to their being inclosed in the bones, where they are not so much stretched or extended as in other parts.

The MARROW is the oily part of the blood, separated by small arteries, and depositated in these cells. Its colour and consistence may therefore

(a) Ruyfch. Thesaur. 9. num. 2. et Advers. dec. 111. obs. 9.

therefore vary according to the state of the vessels, and their distribution on the membranes of the cells.

The marrow as well as the other fat of the body chemically analyzed yields, besides oil and water, a considerable proportion of an acid liquor, but no *alkali* (a). This may be the reason of its being less putrescent than the blood or most other parts of animals (b), which is a necessary quality in a substance that is constantly exposed to a considerable degree of heat, and is more in a stagnating condition than the other liquors.

Besides the arteries, which I mentioned already, p. 9. to be sent from the bones to the marrow, there is at least one artery for each bone; several bones have more, whose principal use is to convey and secrete this oily matter. After these arteries have pierced the solid side of a bone, they are divided into several branches; which soon are distributed every where on the internal *periosteum*, and afterwards spread their branches inwards on the medullary cells, and outwards through the tables of the bone.

The blood, which remains after the secretion of the marrow, is returned by proper veins, which are collected from the membranes into one or two large trunks, to pass out at the same holes or passages at which the artery or arteries enter.

B 3

The

(a) Grutzmacher Dissert. de ossium medulla.—Haller Element. physiolog. lib. 4. sect. 4.

(b) Pringle Append. to camp diseases, exper. 47.

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The general rule of the small vessels decreasing in their capacities as animals advance in age, to which many phaenomena in the animal oeconomy are owing, obtains here : For tho' the trunks of the medullary vessels enlarge as animals turn older ; yet the small branches become smaller ; as is evident from injections, which cannot be made to pass near so far in these vessels of adults as of children. Hence the marrow is bloody in children, oily and balmy in middle age, and thin and watery in old people.

By experiments made on the marrow, when bones of living animals are opened or cut thro' (a), and from the racking pain with which suppurations within bones are frequently attended, we have sufficient proof that the membranes here are sensible, and consequently have nerves distributed to them. *Hippocrates* (b) might therefore say justly, that a wound penetrating into the cavity of a bone may produce a *delirium*.

The vessels of the marrow, wrapt up in one common coat from the *periosteum*, pass thro' the bones by proper canals ; the most considerable of which are about the middle of each bone, and are very oblique. Sometimes these vessels continue at a little distance in their passage when the canal is divided by a small bony partition or two.

From the structure of the contents of the bones, we may judge how these parts, as well

(a) Du Verney, Memoires de l'acad. des sciences, 1700.

(b) Aphorism. § 7. aph 24.

as others, may be subject to oïdema, phlegmon, erysipelas, schirrhus, &c. and may thence be led to a cure of each, before the common consequence, putrefaction, takes place, and frequently occasions the loss of the limb, if not of the patient.

The marrow is of very considerable use to the bones; for by entering their transverse canals, and passing from them into the longitudinal ones, it is communicated to all the plates, to soften and connect their fibres, whereby they are preserved from becoming too brittle; as we see they do in burnt bones, or those long exposed to the air; in people labouring under old age, pox, or scurvy: In all which cases, the oil is either in too little quantity, or has its natural good qualities changed for worse ones.

Besides this advantage which the substance of bones has from the marrow, their articulations are said (a) to receive no less benefit from it: for it is thought that the marrow passes into the articular cavities, through the holes which are in the bones near the large joints. And, as a proof of this, it is alledged, that butchers, upon seeing the greater or lesser quantity of marrow, in the bones of cows, can tell whether they have travelled far or little before they were slaughtered.

When the marrow, after having served the uses mentioned, is reassumed into the mass of blood, (as it is continually, in common with all other secreted liquors that have not passages

(a) Joan de Muralto Vade mecum anat. exercit. 5. § 3.  
Havers Osteolog. nov. disc. 3. p. 179.



## 20 OF THE BONES IN GENERAL.

ges formed for conveying them out of the body), it corrects the too great acrimony communicated to the saline particles of our fluids by their circulation and heat; in the same manner as lixivial salts are blunted by oil in making soap. Hence, in acute diseases, the marrow, as well as the other fat of the body, is quickly wasted, but must be immediately supplied by liquors from the vessels; seeing the cells within the bones, which have no assistance to their contraction from the pressure of the atmosphere, cannot collapse, as the *tela cellularis* under the skin does, when the liquor in its cells is absorbed; the bones therefore are always full.

Since it is the nature of all oil to become thin and rancid when exposed long to heat, and bones have much oil in their firm hard substance, we may know why an ungrateful smell, and dark coloured thin *ichor*, proceed more from corrupted bones than from other parts of the body; and we can understand the reason of the changes of colour which bones undergo, according to their different degrees of mortification.—Hence likewise we may learn the cause of a *spina ventosa*, and of the difficulty of curing all *caries* of bones proceeding from an obstruction, and consequent putrefaction of the marrow; and of the quick pulse, thirst, and *hectic paroxysms*, so often attending these diseases. These *phaenomena* also teach us the reason of the fatal *prognosis* taken from black fetid urine in fevers.

Though bones so far agree in their structure and annexed parts, yet we may observe a considerable

derable difference among them in their magnitude, figure, situation, substance, connection, uses, &c. From which authors have taken occasion to distinguish them into as many classes as they could enumerate of these different circumstances. But these being obvious to every person that looks on bones, I shall only mention one of them; which comprehends very near the whole bones of the body, and at the same time leads us to examine the most considerable variety that is to be found in the disposition of their constituent parts, and in their uses. It is this, that some bones are *broad* and *flat*, while others are *long* and *round*.

The *broad* bones have thin sides, by the plates being soon and equally sent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this structure, they are well adapted to their uses, of affording a large enough surface for the muscles to rise from, and move upon, and of defending sufficiently the parts which they enclose.

The *round* bones have thick strong walls in the middle, and become very thin towards their ends, which is owing to very few plates separating at their middle; where, on that account, the *cancelli* are so fine and small that they are not taken notice of: But such bones are said to have a large reservoir of oil in this place. Towards their ends the lattice-work becomes very thick, and rather more compleat than in the other sort of bones.—These round bones being strong forces naturally applied to them, and

## 22 OF THE BONES IN GENERAL.

and being otherwise exposed to violent injuries, have need of a cylindrical figure to resist external pressure, and of a considerable quantity of oil to preserve them from becoming too brittle. Besides which, they are advantageously provided with thick sides towards their middle, where the greatest forces are applied to injure them; while their hollowness increases their diameter, and consequently their strength to resist forces applied to break them transversely (*a*). Thus, for instance, in estimating the proportional resistance of two cylindrical bones of unequal diameters, but consisting of an equal number of similar fibres uniformly disposed round each, it is plain,

1. That the absolute force of these two bones is equal, because they consist of equal numbers of similar fibres.

2. That the absolute forces of all the fibres in each bone have the same effect in resisting any power applied to break them, as if the sum of all their forces was united in the respective centers of the transverse sections where the fractures are to be made. For, by hypothesis, the fibres being uniformly disposed in each, there is not any fibre in either bone that has not a corresponding fibre; the sum of both whose distances from the axis of revolution (about which all the parts of the bone must revolve in breaking) is equal to two semidiameters of the bone: Consequently each fibre, and all the fibres, may be regarded as resisting at the distance of one semidiameter or *radius* from this axis, that is, in the center.

3. Since

(*a*) Galilei Mechanic, dialog, 2.

3. Since the united force of all the fibres is to be regarded as resisting at a distance from the center of motion equal to the semidiameter, it follows, that the total resistance of all these fibres, or the strength of the bone, is proportional to its semidiameter, and consequently to its diameter.

I have here taken for an example one of the most simple cases for calculating the proportional forces of bones. But, was it not too foreign to the present design, it might be universally demonstrated, that, of whatever figure bones are, and in whatever manner their fibres are disposed, their strength must always be in a ratio, compounded of the area of their transverse sections, or of their quantity of bony matter, and of the distance of the center of gravity of these sections from the center of motion or fulcrum, on which the bone is supposed to be broken (*a*).

Since therefore the strength of bones depends on their number of fibres, or quantity of matter, and the largeness of their diameters, one may conclude, that the part of a bone formerly fractured, and reunited by a *callus*, must be stronger than it was before the fracture happened; because both these advantages are obtained by a *callus*; which is a wise provision, since bones are never set in such a good direction as they were naturally of; and then wherever a *callus* is formed, there is such an obstruction of the vessels, that if the bone was again

(*a*) See the demonstration of this theorem by Dr Porten in the Edinburgh Medical essay, vol. 1, art. 10.



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again broken in the same place, the *ossific* matter could not so easily be conveyed to reunite it. This *callus* may indeed, for want of compression, be allowed to form into a spongy cellular substance (a); but even in this case the strength of the bone is here increased by one or both the causes above mentioned.

Many bones have protuberances, or *processes*\*, rising out from them. If a *process* stands out in a roundish ball, it is called *caput*, or *head*.—If the head is flattened, it obtains the appellation of *condyle*.—A rough unequal protuberance, is called *tuberosity*.—When a *process* rises narrow, and then becomes large, the narrow or small part is named *cervix*, or *neck*.—Long ridges of bones, are called *spines*.—Such processes as terminate in a sharp point, have the general name of *coronæ*†, or *coronoid*, bestowed on them, though most of them receive particular names from the resemblance they have, or are imagined to have to other substances, *e. g. mastoid, styloid, an choroid, coracoid, spinal, &c.*—Such processes as form brims of cavities, are called *superficia*‡.

Processes serve for the advantageous origin and insertion of muscles, and render the articulations firm and stable.

Before

(a) Ruysch. Theaur. 8, n 49. Mus. anat. thec. B. repository. 2 n. 2.

\* Ἀπόφυσεις, ἔκφυσεις, ἔξοχή, πρόβολή, πρόσλημα, Excessus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, enascentia.

† Rostra, glandes.

‡ Ὦραι, ὀφρύες, ἀμβωνες, χεῖλη, Labra.

Before leaving this subject, we must remark, that much the greater number of what are called processes in adult bones, discover themselves in children to be *epiphyses*, or distinct bones, which are afterwards united to the other parts; such are the *styloid* processes of the temporal bones, processes of the *vertebrae*, *trochanters* of the thigh, &c. However, as we design to insist chiefly on the description of the adult skeleton, in which the union of these parts is so intimate, that scarce any vestige remains of their former separation, I shall retain the common appellation of *apophyse*, or process, to all such protuberances; but shall remark the principal ones that have no just title to this name, when they occur in the description of particular bones.

On the surfaces of a great many of the bones there are cavities, or depressions: If these are deep, with large brims, authors name them *styla*\*.—If they are superficial, they obtain the designation of *glænae*, or *glenoid*. These general classes are again divided into several species.—Of which *pits* are small roundish channels sunk perpendicularly into the bone.—*Furrows* are long narrow canals, formed in the surface;—*notches* or *notches*, small breaches in the bone;—*sinuosities*, broad, but superficial depressions without brims;—*fossæ*, large deep cavities, which are not equally surrounded by high brims;—*sinuses*, large cavities within the substance of the bones, with small apertures;—*foramina*, or holes, canals that pierce quite through the substance of the bones.—When

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this

\* Κορυλίδες, ὀμβράροι, Acetabula, pixides, buccellæ.

## 26 OF THE BONES IN GENERAL,

this last sort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The cavities allow the heads of bones to play in them; they lodge and defend other parts; they afford safe passage to vessels, muscles, &c. To mention more would engage us too much in the history of particular bones, which more properly belongs to the demonstration of the *Skeleton*, where we shall have occasion to observe these several species of cavities.

To far the greater number of bones, whose ends are not joined to other bones by an immoveable articulation, there are smaller ones annexed, which afterwards become scarce distinguishable from the substance of the bone itself. These are called *epiphyses*, or *appendices* \*. Some bones have one, others have two, three, or four of these *appendices* annexed by the means of cartilages, which are of a considerable thickness in children, but by age become thinner; the ossification proceeding from the end of the bone on one side, and from the *epiphyses* on the other, till at last, in adults, the place of their conjunction can scarcely be seen on the external surface; and it is only sometimes that we can then see any mark of distinction in the *cancelli* (a).

Several processes (e. g. *trochanters* of the thigh, *spine* of the *scapula*, &c.) have *epiphyses*; and processes frequently rise out from *epiphyses*.

\* *Applantatio, additamentum, adnascens, adnexum, pro-*  
*trone.*

(a) Winslow, *Explication anatomique de corps humain, tirée des os secs*, § 116.

*epiphyses*; for example, at the lower end of the *femur*, *ulna*, *tibia*, &c. (a).

The *epiphyses* are united chiefly to such bones as are destined for frequent and violent motion; and for this purpose they are wisely framed of a larger diameter than the bone they belong to; for by this means, the surface of contact between the two bones of any articulation being increased, their conjunction becomes firmer, and the muscles inserted into them act with greater force, by reason of their axes being further removed from the center of motion. These advantages might indeed have been obtained by the expansion of the end of the bone itself, to a thickness equal to that of the *epiphyses*; but then the constant separation of new plates to form so wide a cellular structure, must have left the solid sides of the bones so thin, as to yield easily, either to the action of the muscles fixed to them, and passing over them, to the weight several of them are obliged to support, or to the application of any other external force.

Several anatomists (b) thought that the *epiphyses* serve other purposes; such as, securing the ligaments of the articulations which rise out from between the bones and them; for, as soon as these parts are intimately joined, the ligaments insinuated betwixt them must have a much stronger connection than they could have to the smooth surface of the bones. Such an interception of the ligament between the body

C 2

of

(a) Vesal. De human. corp. fabrica, lib. 1. cap. 3.

(b) Collumb. De re anatomica, lib. 1. cap. 2. — Fallop. expos. de ossibus, cap. 11.



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of the bone and its *epiphysse* is not to be seen; but as, at this place, the bone remains longer soft than any where else, and the adhesion of the *periosteum*, and of ligaments to bones, is always stronger in proportion to the bones being nearest to the consistence of those parts, which is, being softest, the opinion of these writers concerning the stronger connection of the ligaments, where the bones and *epiphyses* join, is not without some foundation.

Possibly too, by the fibres of *epiphyses* not extending themselves so longitudinally as those of the bones, there may be less chance of the former running into each other, than of the latter.

The softness of the ends of bones may be of some advantage in the womb, and at birth, after which the ossification begins at different points to form *epiphyses*, before the ossification can extend from the middle to the ends of the bones (a).

However solid and compact adult bones are, yet they were once cartilages, membranes, nay, a mere jelly. This needs no further proof, than repeated observations of *embryos* when dissected: And how much more tender must the bones be before that time, when neither knife nor eye is capable to discover the least rudiments of them? By degrees they become more solid, then assume the nature of gristles, and at last ossify; the cohesion of their plates and fibres always increasing in proportion to their increased solidities; as is evident from the time necessary to unravel the texture

(a) Haller de studio medic. p. 267.

of bones of people of different ages, or of dense and of spongy bones, or of the different parts of the same bone, and from the more tedious exfoliations of the bones of adults than of children.

After any part of a bone is fully ossified, its fibres are extended little more in length at that part, tho' they increase there in thickness, and tho' their softer parts continue to become longer (a).

As the solidity of bones increases, their *periosteum* more easily separates from them. When bones are membranous, the *periosteum* and they cannot be distinguished; they appear to be the same substance. When they are cartilages, their membrane adhere so firmly to them, that it is difficult to separate it from them. Where the rigid bony fibres are, the *periosteum* is easily taken off.—Is the similarity of structure and consequent greater attraction of the membrane and substance it incloses, while they are both flexible, the cause of their greater adhesion? or is it owing to the vessels that go from the one to the other being then larger? or do both these causes combine to produce this effect? Or is the membrane or cartilage, which becomes bone afterwards, to be considered as the same substance with the *periosteum* (b)? and must all these plates of bones be therefore said to be layers of the *periosteum* hardened (c)?

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(a) Hales's Vegetable Statics, p. 293.—Du Hamel Memoires de l'acad. des sciences, 1742.

(b) Memoires de l'acad. des sciences, 1744.

(c) Memoires de l'acad. des sciences, 1743.

The ossification of bones depends principally on their vessels being so disposed, and of such diameters, as to separate a liquor, which may easily turn into a bony substance, when it is deprived of its thinner parts; as seems plain from the observation of the callous matter separated after fractures and ulcers, where part of the bone is taken out: For in these cases, the vessels extending themselves, and the liquors added to them, are gradually formed into granulated flesh; which fills up all the space where the bone is taken from, then hardens, till it becomes as firm as any other part of the bone. This happens frequently, even when the ends of the diseased bone are at a considerable distance from each other (*a*).

The induration of bones is also greatly assisted by their being exposed, more than any other parts, to the strong pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer; and such particles of the fluids conveyed in these vessels as are fit to be united to the fibres, are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veias, to be mixed with the mass of blood. In consequence of this, the vessels gradually

(*a*) Hildan. de vuln. gravif. — Med essays, vol. 1. art. 23. — Job a Meckren obs. 69. — Mem. de l'acad. des sciences 1742. — See a collection of such cases in Bochner de ossificatione callo.

ually diminish as the bones harden. From which again we can understand one reason, why the bones of young animals sooner reunite after a fracture than those of old, and why cattle that are put too soon to hard labour, seldom are of such large size as others of the same brood who are longer kept from labour.

That the ossifying of bones greatly depends on pressure, seems to be evinced from the frequent examples we meet with of other parts turning bony, when long exposed to the pressing force of the surrounding parts, or when they are subjected to the like circumstances by their own frequent and violent contraction. Witness, the bones found frequently near the base of the heart in some old men (*a*), and several other creatures. Nay, the muscular substance of the heart has been ossified in such cases, and the arteries of old men often become bony.——The cartilages of the *larynx* are generally ossified in adults.—In beasts of burden, the cartilages between the *vertebrae* of the neck very often change into complete bones; and, being intimately united with the *vertebrae*, the whole appears one continued bone:—Nor is the *periosteum* exempted from such an induration (*c*).

To confirm this argument still farther, we may observe, that bones begin their ossification

*a*) Riolan, Comment. de ossib. cap. 32.—Bartholin. Hist. medic. cent. 1. hist. 50.—Ibid. cent. 2. hist. 45.

*b*) Cheselden, Anatomy, book 1. introd. — Garengeot, Mém. de l'Acad. des sciences, 1726.

*c*) Peyer. Ephemerid. German. decur. 2. ann. 7. observ.



cation at the places where they are most exposed to these causes, viz. in the cylindrical bones from a middle ring, and in the broad ones, at or near their center, from one or more distinct points. The reason of which is, That these parts are contiguous to the bellies of the muscles annexed to the bones, where the swelling of these moving powers is greatest. What the effects of this may be, let any judge, who view some of the bones, as the *scapula*, and *ossa ilium*, which are covered with muscles on each side; how compact and thin they are in adults, where the bellies of the muscles were lodged; whereas in children they are thicker. But this being the middle part of these bones where the greatest number of fibres is, the particular place would have been much thicker in adults, had not this forcible cause been applied, which has not had such effects in children, whose muscles have not been much exercised.—Besides, if we allow that all the parts of a bone are equally increased by the constant supply of new particles, each fibre, and every particle of a fibre, endeavours to make way for its own growth, by pushing the one next to it; and consequently by far the greatest pressure is on the middle, to make the part more firm, and therefore to begin their ossification there. Lastly, the pulsation of the medullary arteries, which enter the bones near to the middle part, may, as authors have alleged, contribute perhaps somewhat to this induration.

From the effects of pressure only it is, that we can account for the bones of old people having their sides much thinner, yet more

ense and solid, while the cavities are much larger than in those of young people; and for the prints of muscles, vessels, &c. being so much more strongly marked on the surfaces of the former than of the latter, if they belong to people of near the same condition in life.—Pressure must likewise be the cause, which, in people of equal ages, makes these prints strong in the bones of those who had much labour and exercise, than they are in people who have had an indolent unactive life.

Perhaps both the causes of ossification above mentioned, may be assisted by the nature of the climate people live in, and the food they use. Whence, in hot countries, the inhabitants sooner come to their height of stature than in the northerly cold regions: And hence seems to have arisen the common practice among the ladies, of making puppies drink brandy or spirit of wine, and of bathing them in these liquors, to prevent their growing big. Nay, it has been observed, that much use of such spirits has occasioned parts, naturally soft, petrify in some, and to ossify in other people at no great age (a).

From the foregoing account of the structure of bones, and of their ossification, we may understand the reasons of the following phenomena.

How the natural colour of bones may be changed by some sorts of food (b).

Why

(a) Litter, Histoire de l'acad. des sciences, 1706.—Geoffroy, Memoires de l'acad. des sciences, 1706.

(b) Philosoph. Transact. 442. art. 8. numb. 443 art. 2. numb. 457. art. 4. Mem. de l'acad. des sciences, 1739, 1742.

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Why the bones of some people are so long in hardening, and in others never compleatly indurate.

Why, in such whose ossification is slow, the bones are generally thicker in proportion to their lengths, especially at their ends; as in the *rickets*.

How hard firm bones have become soft and pliable by diseases (*a*).

Why in some diseases; *epiphyses* separate from bones (*b*), and the ends of fractured bones come asunder many years after their fractures appeared to be cured (*c*).

How bones may waste and diminish (*d*).

How bones may become solid all throughout without any appearance of *cancelli* (*e*).

How, *nodes*, *tophi*, and *exostoses*, happen after the erosion of the external plates of bones in the *lues venerea*, *scurvy*, *rheumatism*, and *gout*.

How bones exfoliate by the rising of granulated flesh from their surface.

How and from what *callus* is formed after fracture (*f*).

Wh

(*a*) Histoire de l'acad. des sciences, 1700.—Mem. 1722. Gagliardi, Anatom. ossium, cap. 2. observ. 3. — Ephem. Germ. decur. 1. ann. 1. obs. 37. et schol. decur. 2. ann. 7. obs. 212. 235. decur. 3. ann. 2. obs. 3. — Philos. Transf. N. 470. § 3. Ibid. vol. 48. § 4. and 44.

(*b*) Memoires de l'acad. des sciences, 1699. — Diemerbroeck Anat. lib. 9. cap. 19. — Cowper's Anat. explic. tab. 96. fig.

(*c*) Anson's Voyage.

(*d*) Cheselden, Anat. book 1. introd. — Hist. de l'acad. des sciences, 1700.

(*e*) Ruysch. Thesaur. 2. arc. 5. thes. 3. loc. 1. numb. thes. 9. numb. 2. not. 3. — Boechmer de call. ossium.

(*f*) Memoires de l'acad. des sciences, 1741. — Delisle de ossium callo.

Why *callus* appears to be rather the continued substance of the *periosteum* than of the bone, while it remains soft and flexible; but seems continued with the bone after it ossifies.

Why *callus* is sensible, while it is soft, but becomes insensible when it hardens.

What occasions sometimes such difficulty in setting fractured bones; or why they never unite, though they are reduced, and all proper means towards a cure are used (b).—Are the bones of women with child more tedious in uniting than those of other people (c)?

Why *calluses*, after fractures, are sometimes very thick and protuberant.

What difference there ought to be in the application of bandages to fractures of the bones of old and of young patients.

How bones, remaining long unreduced after luxation, may have their form so changed as to make their reduction very difficult, if not possible (d).

Whoever is desirous to know, in what time and order each bone and its several parts begin to assume a bony nature, let him consult

*Kerkringius*

a) Mem. de l'acad. 1741.

b) Meekren Observ. medico-chirurg. obs. 71.—Ruyfch. vers. dec. 2. § 2. observ. anat. chir. obs. 4.—Van Swieten Boerhaave Aphor. § 354.

c) Hildan. centur. 5. obs. 87. et cent. 6. obs. 68.—Hof. Transact. No. 494. § 21.

d) Saltzman. Obs. decur. obs. 6.—Memoires de l'acad. chirurgic. tom. 2. p. 155.—Boehmer Instit. osteolog. 96.



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*Kerckingius* (a), who gives us the delineations of abortions from three days after conception, and traces the ossification of the bones from three weeks, and a month, till the time of the birth: To whom should be added *Coiterius* (b) and *Eyssonius* (c). An account of this subject might also be collected out of *Ruyfch's* works, where some of the mistakes committed by the former authors are corrected: and several more particulars, to make the history of the *osteogenea* more accurate, have since been added by *Nesbit* (d) and *Albinus* (e).

I must refer to the authors now quoted for the more curious part of the human osteogeny not having preparations enough to give such a full history of it as is done by them. But I shall endeavour to explain the more useful and necessary part of the osteogeny, by subjoining to the description of each bone of an adult its condition in ripe children; that is, in such as are born at the ordinary time; and shall point out what parts of each are afterwards joined in form of *epiphyses*. This, with the following general rules, seem to me sufficient for understanding what of this subject is necessary in the practice of physic and surgery.

1. Where-ever I mention any parts being cartilaginous, or their being still separable from the other parts of the bone to which they be-

long

(a) *Anthropograph. ichnograph. et osteogenea foetuum.*

(b) *De ossibus foetus abortivi.*

(c) *De ossibus infant. cognoscend. et curand.*

(d) *Human Osteogeny explained.*

(e) *Icones ossium foetus humani; accedit osteogeneae brevis historia.*

long, I would be understood to hint, that, about seven or eight years of age, such parts are ossified and united to their proper bones, unless when it is said, that they are afterwards formed into *epiphyses*.

2. Such as become *epiphyses*, are generally ossified at seven or eight years of age; but, being for the most part moistened by *synovia*, their external surface is still somewhat cartilaginous, and they are not yet united to their bones.

3. At eighteen or twenty years of age the *epiphyses* are entirely ossified, and have blended their fibres so with the body of the bone, as to make them inseparable without violence.

The knowledge of this part of the *osteogeny* is think necessary, to prevent dangerous mistakes in the cure of several diseases. As for example: Without this knowledge, the separation of an *epiphyse* might be mistaken for a fracture or luxation.—The interspace of two parts of a bone not yet joined, might be judged to be a fissure.—A *diastasis*, or separation of such disjoined pieces of a bone, might be thought a fracture.—The protrusion of one piece, or its overlapping any other, could be mistaken for an excrescence or *exstosis*.—Such errors about the nature of a disease would give one very different indications of cure, from what he would have, if he really understood his patient's case. And very often the knowledge of the different inequalities on the surfaces of bones, must direct us in the execution of what is proper to be done to cure several of their diseases.

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Having

Having thus considered the bones when single, we ought next to shew the different manner of their conjunctions \*. To express these, anatomists have contrived a great number of technical terms; about the meaning, propriety, and classing of which, there has unluckily been variety of opinions. Some of these terms it is necessary to retain, since they serve to express the various circumstances of the articulations, and to understand the writers on this subject.

The ARTICULATIONS are most commonly divided into three classes, viz. *symphysis*, *synarthrosis*, and *diarthrosis*.

*Symphysis*, which properly signifies the concretion or growing together of parts, when used to express the articulations of bones, does not seem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it most authors only denote the bones to be connected by some other substance; and as there are different substances which serve this purpose, therefore they divide it into the three following species :

1. *Synchondrosis* †, when a cartilage is the connecting substance: Thus the ribs are joined to the *sternum*; thus the bodies of the *vertebrae* are connected to each other; as are likewise the *ossa pubis*.

2. *Syn*

† Σύνταξις, σύνδεσις, συμβολή, ὁμολία, compositio, connexio, articulatio, conjunctio, nodus, commissura, structura compages

† Amphiarthrosis.

2. *Synneurosis*, or *syndesmosis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syssarcosis*, when muscles are stretched from one bone to another, as they must be where there are moveable joints.

The *second* class of articulations, the *synarthrosis*, which is said to be the general term by which the immoveable conjunction of bones is expressed, is divided into three kinds.

1. The *future* \* is that articulation where two bones are mutually indented into each other, or as if they were sowed together, and is formed by the fibres of two bones meeting while they are yet flexible and yielding, and have not come to their full extent of growth; so that they mutually force into the interstices of each other, till, meeting with such resistance as they are not able to overcome, they are stopped from sprouting out farther, or are reflected; and therefore these indentations are very different both in figure and magnitude: Thus the bones of the head are joined; thus *epiphyses* are joined to the bones, before their full connection and union with them.

Under this title of *future*, the *harmonia* of the antients may be comprehended; scarce any removed bones being joined by plain surfaces).

2. *Gomphosis* † is the fixing one bone into another, as a nail is fixed in a board: Thus the teeth are secured in their sockets.

D 2

3. *Schin.*\* *Epiph.*

(a) Vesal. Observ. Fallop. Examen.

† Conclavatio.



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3. *Schindylesis* or *ploughing* (a), when a thin *lamella* of one bone is received into a long narrow furrow of another: Thus the *processus azygos* of the *sphenoid*, and the nasal process of the *ethmoid* bone, are received by the *vomer*.

The *third* class, or *diarthrosis*\*, is the articulation where the bones are so loosely connected as to allow large motion. This is subdivided into three kinds.

The first is *enarthrosis*, or the ball and socket, when a large head is received into a deep cavity; as the head of the *os femoris* is into the *acetabulum coxendicis*.

The second is *arthrodia*, when a round head is received into a superficial cavity; as in the articulation of the arm-bone and *scapula*. These two species of *diarthrosis* allow motion to all sides.

The third is *ginglimus* †, which properly signifies the hinge of a door or window; in it the parts of the bones mutually receive and are received, and allow of motion two ways: Workmen call it *charnal*.

The *ginglimus* is generally divided into three kinds, to which some (b) give the names of *contiguous* ‡, *distant* ||, and *compound* §.

The first kind of *ginglimus* is, when a bone has several protuberances and cavities, which answer to as many cavities and processes of the other

(a) Keil, Anat. chap. 5. § 3.

\* *Αναρθρωσις*, *dearticulatio*, *abarticulatio*.

† *Articulatio mutua*.

(b) Baker, *Curs. osteolog. demonstr.* 1.

‡ *Proximus*.

|| *Longus*.

§ *Compositus*.

other bone, with which it is articulated; as in the conjunction of the *femur* with the *tibia*.

The second species is, when a bone receives another at one end, and is received by the same bone at the other end; as in the *radius* and *ulna*.

The last sort is, when a bone receives another, and is received by a third; as in the oblique processes of the *vertebræ*.

When I first mentioned the articulations of bones, I said there were different opinions concerning the use of their technical names, *e. g.* It has been said, that *symphysis* should be the name for the immoveable articulations, and *synarthrosis* should be understood to be the conjunction of bones by some connecting medium.—Those who have taken *symphysis* in the sense I did, of its expressing the conjunction of bones with a connecting substance, have disagreed in their definition of it; some inserting, and others leaving out, its allowing motion.—Where they have agreed in their definition, they have not been of the same mind concerning the species of it. For several think the *Symphysis* and *syndesmosis* applicable to so many points which are universally allowed to be classed under the *diarthrosis*, that it must create confusion to name them by any species of the *symphysis*.—Few keep to such a general definition of the *synchondrosis* as I have done; and, whether they determine it to allow no motion, or an obicure or a manifest one, bring themselves into difficulties, because there are examples of all these three kinds.—Some again, by too nicely distinguishing obscure and

manifest motions of bones, have blended the *synarthrosis* and *diarthrosis*, and from thence have branched out the different compound species of articulations that may be formed of them so far, that they could find no examples in the body to illustrate them by.—It would be tedious to enumerate more of the jarring opinions, and it would be far more so to give a detail of the arguments used by the disputants. It is sufficient for my purpose, that it is understood in what sense I take these technical terms; which I do in the following manner.

When I mention the *symphysis* or *synarthrosis*, or any species of them, I shall always understand them according to the explication already given of them. But though the preceeding account of the *diarthrosis*, or articulation of moveable bones, has been almost universally received; yet, seeing it does not comprehend all the moveable articulations of the body, and one of its species does not answer to any notion we can have of the conjunction of two bones, I must beg leave to change the definitions and kinds of these joints.

I would call *diarthrosis* that conjunction of bones, whereby they are fitted for motion, being each covered with a smooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I have no regard to the quantity of motion which they really do perform; the motion being often confined or enlarged by some other cause not immediately depending on the frame of the two surfaces of

the bones forming the particular joint which is considered.

The first species of the *diarthrosis*, viz. the *enarthrosis* or ball and socket, I would define more generally than above, That articulation where a round head of one bone is received into a cavity of another, and consequently, without some foreign impediment, is capable of motion to all sides. Examples of this kind are to be seen in the articulation of the thigh-bone and *ossa innominata*; Arm-bone and *scapula*; *trapezium* and *os naviculare*; *magnum* of the wrist, with the *scaphoides* and *lunare*; first bone of the thumb with the second, &c.

The second sort, or the *arthrodia*, differing from the *enarthrosis*, in the preceeding account, only in the cavity's being more superficial, which makes no essential difference, especially that, in the recent subject, cartilages or ligaments supply the deficiency of bone, ought, in my opinion, to be called with *Vesalius* (a), that articulation of two bones adapted for motion, where it is not at first sight obvious which of the two has the head or cavity, or where they are joined by plain surfaces, or nearly so; such is the conjunction of the *clavicle* with the *scapula*; *ossa cuneiformia* with the *os naviculare*; *metatarsal* bones with the *ossa cuneiformia*, &c. From the nature of this sort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural situation, than is convenient or safe.

*Ginglimus*,

(a) De corp. human. fabrica, lib. 1. cap. 4.



*Ginglimus*, I would reckon that articulation by the form of which the motion of the joined bones must be chiefly confined to two directions which hinges of doors are.

The first species of this is the *trochoides* when one bone turns on another, as a wheel does on its axis: Thus the first *vertebra* of the neck moves on the tooth-like process of the second. This is the most proper kind of *ginglimus*.

The second species should be esteemed the articulation where several prominent and hollow surfaces of two bones move on each other within the same common ligament; as in the knee, elbow, &c.

The third sort of *ginglimus* is, when two bones are articulated to each other at different parts, with a distinct *apparatus* of the motor machines at each; such is the articulation of the *os occipitis* with the first *vertebra* of the neck; of any two contiguous *vertebrae*, by the oblique processes; of the ribs with the bodies and transverse processes of the *vertebrae*; of the *radius* with the *ulna*, *tibia* with the *fibula*, *astragalus* with the *calcaneum*, &c.

I would entirely throw out what is commonly called the third kind of *ginglimus*: For, in examining the conjunction of a bone with two others, as in the common example of a *vertebra* joined with the one above and below, the connection of the middle one with each of the other two ought to be considered separately; otherwise we might with the same propriety esteem the articulations that the long bones, the *femur*, *tibia*, *humerus*, &c. have at their dis-

feren-

ent ends, as one articulation; which is ab-

If the moveable bones are not connected and kept firm by some strong substance, they could be luxated at every motion of the joints: and if their hard rough unequal surfaces were to play on each other, their motion would not only be difficult, but the loss of substance from friction would be great. Therefore *ligaments* are made to obviate the first, and *cartilages* to prevent the other inconveniency. But because ligaments and cartilages turn rigid, inflexible, and rough, unless they are kept moist, a sufficient quantity of proper liquors is supplied for their lubrication, and to preserve them in a flexible state. Seeing then these parts are so necessary to the articulations, I shall next consider their structure, situation, and uses, so far as they are subservient to the bones, and their motions.

**LIGAMENTS** \* are white flexible bodies, thicker and firmer than membranes, and not so hard or firm as cartilages. without any remarkable cavity in their substance, difficultly stretchable, and with little elasticity; serving to connect one part to another, or to prevent the parts to which they are fixed from being removed out of that situation which is useful and safe.

After maceration in water, the ligaments can easily be divided; and each ligamentous body appears composed of fibres, the largest of which are disposed in a longitudinal direction.

The

\* σύνδεσμος, νεῦρον, copula, vincula.

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The *arteries* of ligaments are very conspicuous after a tolerable injection, and the larger trunks of their veins are sometimes to be seen full of blood.

Such ligaments as form the sides of cavities, have numerous orifices of their arteries opening upon their internal surface, which keeps it always moist: If we rub off that moisture and then press the ligament, we can see the liquor issuing out from small pores; and we can force thin liquors injected by the arteries into the cavities formed by ligaments.

These exhalent arteries must have corresponding absorbent *veins*, otherwise the cavities would soon be too full of liquor.

Ligaments then must be subject to the diseases common to other parts, where there is a circulation of fluids, allowance always being made for the size of vessels, nature of the fluids, and firmness of the texture of each part.

Authors generally say, that ligaments are insensible: and consequently it may be inferred, that they have no nerves bestowed on them. But the violent racking pain felt on the least motion of a joint labouring under a *rheumatism*, the seat of which disease seems often to be in the ligaments, and the insufferable torture occasioned by incisions of ligaments, and by a collection of acrid matter in a joint, or by *tophi* in the gout, would persuade us, that they are abundantly supplied with nerves.

The ligaments which connect the moveable bones commonly rise from the conjunction of the *epiphyses* of the one bone, and

inserted into the same place of the other; where *epiphyses* are not, they come out from the *cervix*, and beyond the *supercilia* of articulated bones; and after such a manner, in both cases, as to include the articulation in a sheath or bag, with this difference, depending on their different motions, that where the motion is only to be in two directions, the ligaments are strongest on those sides towards which the bones are not moved; and when a great variety of motions is designed to be allowed, the ligaments are weaker than in the former sort of articulations, and are nearly of the same strength all round.

Part of the capsular ligaments is composed of the *periosteum*, continued from one bone to another, as was observed p. 2. and their interlayer is continued on the parts of the bone and cartilage which the ligament includes (a).

Besides these common capsular ligaments of the joints, there are particular ones in several places, either for the firmer connection of the articulated bones, or for restraining and confining the motion to some one side; these are the *cross* and *lateral* ligaments of the knee, the *round* one of the thigh, &c.

From this account of the ligaments, we may conclude, that, *ceteris paribus*, in what articulation the ligaments are few, long, and weak, the motion is more free and quick; luxations happen frequently: And, on the contrary, where the ligaments are numerous, short, and strong, the motion is more confined; such a joint is less exposed to luxations (a)

(a) Nesbit, Osteogen.—Philos. transact. No. 470. § 6.



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(a).—Whence we may judge how necessary it is to attend to the different ligaments, and the changes which have been made on them by a luxation, when it is to be reduced.

Ligaments also supply the place of bones in several cases to advantage: Thus the parts of the *pelvis* are more safely supported below by ligaments, than they could have been by bone. The ligaments placed in the grooves of the *ossa innominata*, and between the bones of the fore-arm and leg, afford convenient origin to muscles. — Immoveable bones are firmly connected by them; of which the conjunction of the *os sacrum* and *innominata* is an example. — They afford a socket for moveable bones to play in, as we see part of the *astragalus* does on the ligament stretched from the heel-bone to the *scaphoid*.

Numerous inconveniencies may arise from too long or short, strong or weak, lax or rigid ligaments.

CARTILAGES \* are solid, smooth, white elastic substances, between the hardness of bones and ligaments, and covered with a membrane, named *perichondrium*, which has the same structure and use to them as the *periosteum* is to the bones.

Cartilages are composed of plates, which are formed of fibres, disposed much in the same way as those of bones are; as might be reasonably concluded from observing bones in a cartilaginous state before they ossify, and from seeing, on the other hand, so many cartilages become bony. This may be still further confirmed

(a) Fabric. ab Aquapend. de articul. part. utilit. pars 3.  
Κορδοποι.

med, by the *exfoliation* which cartilages are subject to, as well as bones.

The *perichondrium* of several cartilages, for example, those of the ribs and *larynx*, has series which can be equally well injected with those of the *periosteum*; but the vessels of that membrane in other parts, *e. g.* the articular cartilages, are smaller, and in none of them does injection enter deep into the substance of the cartilages; nay, madder, mixed with the blood of animals, does not change the colour of cartilages, as it does that of bones (*a*).

The granulated flesh which rises from the ends of metacarpal or metatarsal bones, when the cartilage exfoliates, after a finger or toe has been taken off at the first joint, is very visible, from which the existence of nerves in cartilages may be inferred.

While cartilages are in a natural state, it is to be remarked, *first*, That they have no cavity in their middle for marrow. *Secondly*, That their outer surface is softest, which renders them more flexible. *Thirdly*, That they do not appear to change their texture near so much by acids as bones do. And, *lastly*, That the specific gravity of cartilages is near a third less than that of bones; so the cohesion of their several plates is not so strong as in bones: whence cartilages laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much sooner than bones do.

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Cartilages

(a) *Philos. Transact.* No. 442. art. 8. No. 443. art. 2. 457. art. 4. — *Mem. de l'acad. des sciences* 1739 et 1742. — *Dehtleef de ossium callo.*

Cartilages seem to be principally kept from ossifying, either by being subjected to alternate motions of flexion and extension, the effects of which are very different from any kind of simple pressure, or by being constantly moistened (a): Thus, the cartilages on the articulated ends of the great bones of the limbs, and the moveable ones placed between the moving bones in some articulations, which are obliged to suffer many and different flexions, and are plentifully moistened, scarce ever change into bone; while those of the ribs and larynx are often ossified. — The middle angular part of the cartilages of the ribs, which is constantly in an alternate state of flexion and extension by being moved in respiration, is always the last of becoming bony. — In the *larynx*, the *epiglottis*, which is oftener bended and more moistened than the other four cartilages, seldom is ossified, while the others as seldom escape it in adults.

The cartilages subservient to bones, are sometimes found on the ends of bones which are joined to no other; but are never wanting on the ends, and in the cavities of such bones as are designed for motion (b). Cartilages are interposed between such other cartilages to cover the heads and cavities of articulated bones; nay, they are also placed between moveable bones.

The uses of cartilages, so far as they regard bones, are, to allow, by their smoothness, to move bones as are designed for motion, to slide

(a) Havers Osteolog. nov.

(b) Cels. de re medic. lib. 8. cap. 1.

without detrition, while, by their flexibility, they accommodate themselves to the several figures necessary in different motions, and, by their elasticity, they recover their natural position and shape as soon as the pressure is removed.—This springy force may also assist the motion of the joint to be more expeditious, and may render shocks in running, jumping, &c. less.—To these Cartilages we chiefly owe the security of the moveable articulations: For without them the bony fibres would sprout out, and intimately coalesce with the adjoining bone; whence a true *anchylosis* must necessarily follow; which never fails to happen when the cartilages are eroded by a hard matter, or ossified from want of motion or defect of liquor, as we see often happens after wounds of the joints, *paidarthrocace*, *scapula*, and *spina ventosa*, or from old age, and long immobility of joints (a).—Hence we may know what the annihilation is which is to be made of the head of a bone, and of the cavity for lodging it, after an unreduced fracture (b). The moveable cartilages interposed in joints serve to make the motions both freer and more safe than they would otherwise be.—Those placed on the ends of bones that are not articulated, as on the head of the *os illium*, base of the *scapula*, &c.

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(a) Columb. de re anat. lib. 15. — Deslandes Hist. de l'Académie des sciences 1716 — Phil. transact. No. 215. — Ibid. 1746 § 16.

(b) Hildan. de ichor. et melicer. acri Celsi, cap. 5 — Ruysch. anat. 8. No. 103. Saltzman in act. Petropolit. Tom 3. p. 75.



serve to prevent the bony fibres from growing out too far.—Cartilages sometimes serve as ligaments, either to fasten together bones that are immoveably joined, such are the cartilages between the *os sacrum* and *ossa illiaca*, the *ossa pubis*, &c. or to connect bones that enjoy manifest motion, as those do which are placed between the bodies of the true *vertebrae*, &c.—Cartilages very often do the office of bones to greater advantage than these latter could, as in the cartilages of the ribs, those which supply brims to cavities, &c.

Too great thickness or thinness, length or shortness, hardness or suppleness of cartilages may therefore cause great disorders in the body.

The liquor, which principally serves to moisten the ligaments and cartilages of the articulations, is supplied by glands, which are commonly situated in the joint, after such a manner as to be gently pressed, but not destroyed by its motion. By this means, when there is the greatest necessity for this liquor, that is, when the most frequent motions are performed, the greatest quantity of it may be separated. These glands are soft and pappy, but not friable: In some of the large joints they are of the conglomerate kind, and a great number of small glandules are wrapped up in one common membrane. Their excretory ducts are long, and hang loose, like many fringes, within the articulation; which by its motion and pressure, prevents obstructions in the body of the gland or its excretories, and promotes the return of this liquor, when

can fit to be taken up by the absorbent vessels, which must be in the joints, as well as in the other cavities of the body; and, at the same time, the pressure on the excretory vessels hinders a superfluous unnecessary secretion, while the fimbriated disposition of these excretories does not allow any of the secreted liquor to be pushed back again by these canals towards the glands (a).

Very often these fountains of slimy liquor appear only as a net-work of vessels.—— Frequently they are almost concealed by cellular membranes containing the fat—and sometimes small simple mucous *folliculi* may be seen (b).

The different joints have these organs in different numbers and sizes; the conglomerate ones don't vary much, especially as to situation, in the similar joints of different bones; but the others are more uncertain.

Upon pressing any of these glands with the finger, one can squeeze out of their excretories a mucilaginous liquor, which somewhat resembles the white of an egg, or *serum* of the blood; but it is manifestly salt to the taste. It does not coagulate by acids or by heat, as the *serum* does, but by the latter turns first thinner, and, when evaporated, leaves only a thin salt film.

The quantity of this *mucilage*, constantly applied, must be very considerable, since we see what a plentiful troublesome discharge of watery matter follows a wound or ulcer of any joint;

E. 3.

(a) Cowper, *Anatom. explicat.* tab. 79. lit. E. E.

(b) Morgagn, *Adversar. 2. animad.* 23.

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joint; of which liquor the mucilage is a considerable part.

The vessels which supply liquors for making the secretion of this mucilage, and the veins which bring back the blood remaining after the secretion, are to be seen without any preparation; and, after a tolerable injection of the arteries, the glands are covered with them.

In a sound state, we are not conscious of any sensibility in those glands; but, in some cases which I have seen, when they inflame and suppurate, the most racking pain is felt in them: a melancholy, though a sure proof that they have nerves.

These mucilaginous glands are commonly lodged in a cellular substance; which is also to be observed in other parts of the bag formed by the ligaments of the articulation; and contains a fatty matter, that must necessarily be attenuated, and forced through the indurating membranes into the cavity of the joint by the pressure which it suffers from the moving bones.

If then the oil is conveyed from this cellular substance; and if the attenuated marrow passes from the *cancelli* of the bones by the large pores near their ends, or in their cavities, and sweats through the cartilages into the articulations; which it may, when assisted by the constant heat and action of the body, more easily do, than when it escapes through the compact substance of the bone in a skeleton: If, I say, this oil is sent to

at, and is incorporated with the mucilage, and with the fine lymph that is constantly flowing out at the extremities of the small arteries distributed to the ligaments, one of the fittest *liniments* imaginable must be produced; for the *mucus* diluted by the lymph contributes greatly to its lubricity, and the oil preserves it from hardening. How well such mixture serves the purpose it is designed for, *Boyle* (a) tells us he experienced in working an air-pump; for the sucker could be moved with much less force after being moistened with water and oil, than when he used either one or other of these liquors: And I believe every one, at first view, will allow the diluted mucilage to be much preferable to simple water. The *synovia* \*, as this liquor composed of oil, mucilage, and lymph, is commonly now called, while in a sound state, effectually preserves all the parts concerned in the articulations soft and flexible, and makes them slide easily on each other, by which their mutual friction and overheating is prevented, in the manner daily practised in coach and cart wheels, by bemearing them with grease and oil.

After the liquor of the articulations becomes thin and unserviceable, by being constantly pounded and rubbed between the moving bones, it is reassumed into the mass of blood by the absorbent vessels.

When the *synovia* is not rubbed betwixt the bones, it inspissates. And sometimes, when the

(a) Physico-mechanic experim.

\* *Muſa*, *mucus*, *axungia*.



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the head of a bone has been long out of its cavity, this liquor is said to fill up the place of the bone, and hinder its reduction; or if a joint continues long unmoved, it is also said to cement the bones, and occasion a true *anchylosis* (a). — If the *synovia* becomes too acrid, it erodes the cartilages and bones; and frequently happens to those who labour under the *lues venerea*, *scurvy*, *scrophula*, or *spina ventrosa*. — If this liquor is separated in too small quantity, the joint becomes stiff; and when with difficulty it is moved, a crackling noise is heard, as people advanced in years frequently experience (b). — If the mucus and lymph are deposited in too great quantity, and the absorbent vessels do not perform their office sufficiently, they may occasion a dropsy of the joints (c). — From this same cause also the ligaments are often so much relaxed as to make the conjunction of the bones very weak: Thence arise the luxations from an internal cause, which are easily reduced, but difficultly cured (d). — Frequently, when such a superfluous quantity of this liquor is pent up, it becomes very acrid, and occasions a great train of bad symptoms; such as swelling and pain of the joints, long sinuous ulcers, and *fungi*, rotten bones, immobility of the joints.

mar

(a) Pare, Chirurgie, livre 15 chap. 18. et livre 16 chap. 5.

(b) Galen de an. part. lib. 12. cap. 2. — Fabrici Aquapend. de articul. part. utilitat. pars 3. — Bartholin. Hist. medic. cent. 3. hist. 11.

(c) Hilden. de ichore et melicaria acri Celsi.

(d) Hippocrat. de locis in homine, § 14. et de articul.

cor and atrophía of the whole body, hectic  
ers, &c. (d)—From a depravity in the  
ood or diseases in the organs that furnish the  
ovia of the joints, it may be greatly chan-  
d from its natural state; it may be purulent  
er inflammation, mucous in the white swell-  
s, gelatinous in the rheumatism, chalky  
m the gout, &c.; hence a great variety of  
orders in the joints (e).

THE

- (y) Hildan. de ichore et melliceria acri Colli.  
(z) See Reimar Dissert. de fungo articulari.

У М О Т А И

THE  
ANATOMY  
OF THE  
HUMAN BONES.

PART II.

Of the SKELETON.

THOUGH any dry substance may be called *skeleton*, yet, among anatomists, this word is universally understood to signify the bones of animals connected together, or the teguments, muscles, bowels, glands, nerves, and vessels are taken away \*.

A skeleton is said to be a *natural* one, when the bones are kept together by their own ligaments: and it is called *artificial*, when the bones are joined with wire, or any other substance which is not part of the creature to which they belonged. Small subjects, and such whose bones are not fully ossified, are commonly prepared the first way; because, were all



all their parts divided, the nicest artist could not rejoin them, by reason of their smallness and of the separation of their unossified parts: whereas the bones of large adult animals are soonest and most conveniently cleaned when single, and are easily restored to, and kept in their natural situation. — Sometimes the skeleton of the same animal is prepared in both these ways; that is, the smaller bones are kept together by their natural ligaments, and the larger ones are connected by wires, or some such substances.

Before we proceed to the division and particular description of the skeleton, it is worth while to remark, that when the bones are put into their natural situation, scarce any one of them is placed in a perpendicular bearing to another: though the fabric composed of them is so contrived, that, in an erect posture, a perpendicular line, from their common center of gravity, falls in the middle of their common base (*a*). On this account, we can support ourselves as firmly, as if the axis of all the bones had been a straight line perpendicular to the horizon; and we have much greater quickness, ease, and strength in several of the most necessary motions we perform. It is true indeed, that where-ever the bone on which any part of our body is sustained declines from a straight line, the force required in the muscles, to counteract the gravity of that part, is greater than otherwise needed.

(*a*) Cowper Anat. of human bodies, explic. of tab. 88.

needed to have been : But then this is effectually provided for in such places, by the number and strength of the muscles. So long therefore as we remain in the same posture, a considerable number of muscles must be in a constant state of contraction ; which we know, both from reason and experience, must soon create an uneasy sensation. This we call, being weary of one posture : An inconvenience that we should not have had in standing erect, if the bearing of all the bones to each other had been perpendicular ; but is more than compensated by the advantages above mentioned.

The human skeleton is generally divided into the HEAD, the TRUNK, the SUPERIOR and the INFERIOR EXTREMITIES.

## OF THE HEAD.

BY the *HEAD* is meant all that spheroidal part which is placed above the first bone of the neck. It therefore comprehends the *cranium* and bones of the *face*.

The *cranium* \*, helmet, or brain-case, consists of several pieces, which form a vaulted cavity, for lodging and defending the brain and *cerebellum*, with their membranes, vessels, and nerves.

The cavity of the *cranium* is proportioned to its contents. Hence such a variety of its size is observed in different subjects ; and hence it is neither so broad nor so deep at its fore-

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part,

\* Κόρυς, κύρος, κῶδρια, σκαπίον, calva, calvaria, cerebricola, theca et olla capitis, testa capitis, scutella capitis.

part, in which the anterior lobes of the brain are lodged, as it is behind, where the large posterior lobes of the brain, and the whole *cerebellum*, are contained.

The roundish figure of the skull, which makes it more capacious, and better able to defend its contents from external injuries, is chiefly owing to the equal pressure of these contained parts as they grow and increase before it is entirely ossified.—It is to be observed however, that the sides of the *cranium* are depressed below a spherical surface by the strong temporal muscles, whose action hinders here the uniform protrusion of the bones, which is more equally performed in other parts, where no such large muscles are. In children, whose muscles have not acted much, and consequently have not had great effects on the bones, this depression is not so remarkable; and therefore their heads are much rounder than in adults. These natural causes, differently disposed in different people, produce a great variety in the shapes of skulls, which is still increased by the different management of the heads of children when very young: So that one may know a *Turk's* skull by its globular figure, a *German's* by its breadth and flatness of the *occiput*, *Dutch* and *English* by their oblong shapes, &c. (a). Two advantages are reaped from this flatness of the sides of the *cranium*, viz. the enlargement of our sphere of vision, and more advantageous situation of our ears, for receiving a greater quantity of sound, and for being less exposed to injuries.

(a) Vesal. lib. 1. c. 5.

The external surface of the upper part of the *cranium* is very smooth, and equal, being only covered with the *periosteum*, (common to all the bones; but in the skull, distinguished by the name of *pericranium*), the thin *frontal* and *occipital* muscles, their tendinous *aponeuroses*, and with the common teguments of the body; while the external surface of its lower part has numerous risings, depressions, and holes, which afford convenient origin and insertion to the muscles that are connected to it, and allow safe passage for the vessels and nerves that run through and near it.

The internal surface of the upper part of the skull is commonly smooth, except where the vessels of the *dura mater* have made furrows in it, while the bones were soft.——Surgeons should be cautious when they trepan here, lest, in sawing or raising the bone where such furrows are, they wound these vessels.——In the upper part of the internal surface of several skulls, there are likewise pits of different magnitudes and figures, which seem to be formed by some parts of the brain being more luxuriant and prominent than others. Where these are, the skull is so much thinner than any where else, that it is often rendered diaphanous, the two tables being closely compacted without a *diploe*; the want of which is supplied by vessels going from the *dura mater* into a great many small holes observable in the pits. These vessels are larger, and much more conspicuous than any others that are sent from the *dura mater* to the skull; as evidently appears from the drops of blood they pour out, when



the scull is raised from the *dura mater* in a recent subject; and therefore they may furnish a sufficient quantity of liquors necessary to prevent the brittleness of this thin part.—The knowledge of these pits should teach surgeons to saw cautiously and slowly through the external table of the scull, when they are performing the operation of the *trepán*; since, in a patient whose *cranium* has these pits, the *dura mater* and brain may be injured, before the instrument has pierced near the ordinary thickness of a table of the scull.—The internal base of the scull is extremely unequal, for lodging the several parts and *appendices* of the brain and *cerebellum*, and allowing passage and defence to the vessels and nerves that go into, or come out from these parts.

The bones of the *cranium* are composed of two tables, and intermediate *cancelli*, commonly called their *diploe* \*. The external table is thickest; the inner, from its thinness and consequent brittleness, has got the name of *vitrea*. Whence we may see the reason of those mischievous consequences which so often attend a collection of matter in the *diploe*, either from an external or internal cause, before any sign of such a collection appears in the teguments that cover the part of the scull where it is lodged (a).

The *diploe* has much the same texture and uses in the scull, as the *cancelli* have in other bones.

\* *Medullium, commissura.*

(a) Bonet. Sepulchret. anat. lib. 1. § 1. obs. 96.—103.

The *diploe* of several old subjects is so obliterated, that scarce any vestige of it can be seen; either is it observable in some of the hard bony bones at the base of the skull. Hence a useful caution to surgeons who trust to the yielding, want of resistance, and change of sound, as certain marks in the operation of the trepan, for knowing when their instrument has sawed through the first table, and reached the *diploe* (a). In other people, the *diploe* becomes of a monstrous thickness, while the tables of the skull are thinner than paper.

The *cranium* consists of eight bones, six of which are said to be proper, and the other two reckoned common to it and to the face.—The six proper are the *os frontis*, two *ossa parietalia*, two *ossa temporum*, and the *os occipitis*.—The common are the *os ethmoides* and *os sphenoides*.

The *os frontis* forms the whole fore-part of the vault; the two *ossa parietalia* form the upper and middle part of it; the *ossa temporum* compose the lower part of the sides; the *os occipitis* makes the whole hinder part, and some of the base; the *os ethmoides* is placed in the fore-part of the base, and the *os sphenoides* is in the middle of it.

These bones are joined to each other by five sutures; the names of which are the *coronal*, *lambdoid*, *sagittal*, and two *squamous*.

The *coronal* \* future is extended over the head, from within an inch or so of the external

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(a) Bartholin. Anat. reform. lib. 4. cap. 4.

\* Στεφανία, arcualis, puppis.

nal *canthus* of one eye, to the like distance from the other ; which being near the place where the antients wore their *vitta*, *corona*, or garlands, this suture has hence got its name.— Though the indentations of this suture are conspicuous in its upper part, yet an inch or more of its end on each side has none of them ; for it is squamous and smooth there.

The *lambdoidal* \* suture begins some way below, and farther back than the *vertex* of the crown of the head, whence its two legs are stretched obliquely downwards, and to each side in form of the *Greek* letter  $\Delta$ , and are now generally said to extend themselves to the *base* of the skull ; but formerly anatomists (a) reckoned the proper *lambdoid* suture to terminate at the *squamous* sutures, and what is extended at an angle down from that on each side, where the indentations are less conspicuous than in the upper part of the suture, they called *additamentum sutura lambdoidis* †.

This suture is sometimes very irregular, being made up of a great many small sutures which surround so many little bones that are generally larger and more conspicuous on the external surface of the skull, than internally. These bones are generally called *triquetra* or *Wormiana* ; but some other name ought to be given them, for they are not always of a triangular

\* *Laudæ, proræ, hypsiloïdes.*

(a) *Vesal, Anat. lib 1 cap. 6.*

† *Lambdoïdes harmonialis, lambdoïdes inferior, occipitalis, corona.*

lar figure; and older anatomists (*a*) than *Aus Wormius* (*b*) have described them.—The specific virtue which these bones were once thought to have in the cure of the epilepsy (*c*) is not now ascribed to them; and anatomists generally agree, that their formation is owing to a greater number of points than ordinary ossification in the scull, or to the ordinary ones of the *cranium* not extending their ossification far enough or soon enough; in which case, the unossified interspace between such bones begins a separate ossification in one or more points: from which the ossification is extended to form as many distinct bones as there are points that are indented into the large ordinary bones, and into each other.—Probably those children who have a large opening in this place at their birth, will have the largest *triquetra*.——To confirm this account of the formation of these little bones, we may remark, that such bones are sometimes seen in other sutures, as well as in the *lambdoid* (*d*), and they are sometimes in one table of the scull, and not in the other (*e*).

The *sagittal* future \* is placed longitudinally in the middle of the upper part of the scull, and

*a*) Eustach. *Ossium examen*.—Bauhin *Theat. anat. lib. cap. 5.* — Paaw in *Hippocrat. de vulner. cap. p. 56.*

*b*) Musæum, lib. 3. cap. 26.

*c*) Bauhin. et Paaw. *ibid.* — Bartholin. *Anat. reform. lib. 4: cap. 5.* — Hildan, *Epistol. 65*

*d*) See examples in *Vesal. lib. 1. cap. 6. fig. 4.* — Paaw in *Hippocrat. de cap. vuln.* — Bartholin. *Hist. anat. cent. 1. p. 51.* — Rusch, *Mus. anat.* — Sue *Trad. d'osteolog. p. 47.*

*e*) Humald. in *Mem. de l'acad. des sciences, 1730*

ῥαβδοειδής, ὀβελία, ἐπιτεγγυσα, *Instar virgae, nervalis, ar teli, instar veru, secundum capitis longitudinem prore-*  
*conjungens, columnalis, recta, acualis.*



and commonly terminates at the middle of the *coronal*, and of the *lambdoid* sutures; between which it is said to be placed, as an arrow is between the string and bow.—However this suture is frequently continued through the middle of the *os frontis*, down to the root of the nose, which, some (a) say, oftener happens in women than men; but others (b) alledge, that it is to be met with more frequently in male skulls than in female: Among the skulls which I have seen thus divided, the female are the most numerous.—Several (c) have delineated and described the *sagittal* suture, sometimes dividing the *occipital* bone as far down as the great hole through which the *medulla spinalis* passes. This I never saw.

In some old skulls that are in my possession there is scarce a vestige of any of the three sutures which I have now described. In other heads, one or two of the sutures only disappear; but I never could discover any reason for thinking them disposed in such different manners in skulls of different shapes, as some authors alledge they are (d).

The *squamous agglutinations*, or *false sutures* †, are one on each side, a little above the ear, of a semicircular figure, formed by the

(a) Riolan. Comment. de ossib. cap. 8.

(b) Vesal. lib. 1. cap. 6. et in epitome.

(c) Vesal. lib. 1. cap. 5. fig. 3. 4. et in text. cap. 6.—Paaw. in Cels. de re medic. cap. 1.—Laurent. Hist. anat. 2. cap. 16.

(d) Hippocrat. de vulner. capitis, § 1.—Galen, de diet. et de usu part. lib. 9 cap. 17.

† Λεπιδοειδῆ, προσκολλήματα, κροταφίαι, temporales, ticales, mendosæ, harmoniales, commissuræ in unguem.

erlapping (like one scale upon another) of the upper part of the *temporal* bones on the lower part of the *parietal*, where, in both bones, there are a great many small risings and furrows, which are indented into each other; though these inequalities do not appear when the bones are separated. In some skulls indeed the indentations here are as conspicuous externally as in other futures (*a*); and what is commonly called the posterior part of this squamous future, always has the evident serrated margin; and therefore is reckoned by some (*b*), a distinct future, under the name of *additamentum posterius futura squamosa*.—I have seen too squamous futures on the same temple, with a semicircular piece of bone between them (*c*).

We ought here to remark, that the true squamous sort of future is not confined to the junction of the temporal and parietal bones, but is made use of to join all the edges of the bones on which each temporal muscle is placed: For the two parts of the sphenoidal future which are continued from the anterior end of the common squamous future just now described, of which one runs perpendicularly downwards, and the other horizontally forwards, and the lower part of the coronal future already taken notice of, may all be justly said to pertain

(a) Columb. de re anat. lib. 1. cap. 4.—Dionis, Anat. 3. const. des os.

(b) Alb. de ossib. § 54.

(c) Sue Trad. d'osteolog. p. 48.

(d) Vesal. Anat. lib. 1. cap. 6.—Winslow, Mem. de l'acad. des sciences, 1720.

pertain to the squamous *suture* — The manner how I imagine this sort of suture is formed in these places, is, That, by the action of the strong temporal muscles on one side, and by the pressure of the brain on the other, the bones are made so thin, that they have large enough surfaces opposed to each other to stop the extension of their fibres in length, and thus to cause the common serrated appearance of sutures explained in p. 39. but the narrow edge of the one bone slides over the other. The *squamous* form is also more convenient here; because such thin edges of bones, when accurately applied one to another, have scarcely any rough surface, to obstruct or hurt the muscle in its contraction; which is still further provided for, by the manner of laying these edges on each other; for, in viewing their outside, we see the temporal bones covering the sphenoidal and parietal, and this last supporting the sphenoidal, while both mount on the frontal: from which disposition it is evident that while the temporal muscle is contracted, which is the only time it presses strongly in motion on the bones, its fibres slide easily over the external edges. Another advantage in this is, that all this bony part is made stronger by the bones thus supporting each other.

The bones of the skull are joined to the bones of the face, by *schyndeleses* and *sutures*. — The *schyndelesis* is in the partition of the nose. — The sutures said to be common to the cranium and face are five, viz. the *ethmoidal*, *sphenoidal*, *transverse*, and two *zygomatic*. — Parts ha

of these sutures are at the junction of one of the bones of the skull.

The *ethmoidal* and *sphenoidal* sutures surround the bones of these names; and in some cases help to make up other sutures, particularly the *squamous* and *transverse*; and in other parts there is but one suture common to the two bones.

The *transverse* suture is extended quite across the face, from the external *canthus* of one orbit to the same place of the other, by sinking into the *canthus* down the outside of the orbit to its bottom; then mounting upon its inside it is continued by the root of the nose to the internal part of the other orbit, and then up again on its outside to the other *canthus*.

It may be here remarked, that there are no interruptions of this suture in the course we have described; for the bones are not continuous every where, but are separated, to form holes and apertures, to be mentioned hereafter.

The *zygomatic* sutures are one on each side, short, and slanting from above obliquely forwards and backwards, to join a process of the cheek-bone to one of the *temporal* bones, which advances towards the face; so that the processes thus united, form a sort of bridge, or *jugum*, under which the *temporal* muscles pass; on which account the processes, and sutures joining them, have been called *zygomatic*.

It must be observed, that the indentations of the sutures do not appear on the inside of the *jugum*, by much so strong as on the outside; the bones seem almost joined in a straight line:



line: nay, in some skulls, the internal face is found entire, while the sutures are manifest without; which may possibly be owing to the less extent of the concave than of the convex surface of the *cranium*, whereby the fibres of the internal side would be stretched farther out at the edges of the bones, than the exterior ones, if they were not resisted. The resistances are the fibres of the opposite bone, the parts within the skull, and the *diploe*; which the last being the weakest, the most advanced fibres or *serræ* run into it, and leave the contiguous edges equal, and more ready to unite: whereas the *serræ* of the external table have space enough for their admission between the fibres of the opposite bone, and therefore remain of the indented form, and are less liable to the concretion, whereby the sutures are obliterated (a).——By this mechanism there is no risk of the sharp points of the bone growing inwards, since the external *serræ* of each of the conjoined bones rest upon the internal smooth-edged table of the other; external forces applied to these parts are strongly resisted, because the sutures cannot yield, unless the serrated edges of the one bone, and the plain internal plate of the other are broken (b).

The advantages of the sutures of the *cranium* are these: 1. That this *capsula* is more easily formed and extended into a spherical figure, than if it had been one continued bone.

(a) Hunauld, *Memoires de l'acad. des sciences*, 1730.

(b) Winslow, *Memoires de l'acad. des sciences*, 1730.

That the bones which are at some distance from each other at birth, might then yield, and allow to the head a change of shape, accommodated to the passage it is engaged in. Hence, in hard labour of child-bed, the bones of the *cranium*, instead of being only brought into contact, are sometimes made to hunt one upon the other. 3. It is alledged, that, thro' the sutures, there is a transpiration of steams from the brain, which was the old doctrine; or some communication of the vessels without, and of those within the skull, greater here than in any other part of the *cranium*, according to some moderns; and therefore cucuphæ, fomentations, cataplasms, cephalic plaisters, blisters, are applied, and issues are made, or cut in the head, at those places where the sutures are longest in forming, and where the connection of the bones is afterwards loosest, for the cure of a *phrenitis*, *manicured*, *inveterate headach*, *epilepsy*, *apoplexy*, and other diseases of the head. The favourers of this doctrine of transpiration, or communication of vessels at the sutures, endeavour to support it by observations of persons subject to head-achs which caused death, from the sutures being too closely united (a). 4. That the *dura mater* may be more firmly suspended to its processes, which insinuate themselves into the conjunction of the bones; for doing this generally, and where the greatest necessity of adhesion is, the sutures are disposed at nearly equal

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Columb. de re anat. lib. 1. cap. 5. — Verduc. neu-  
rologie, chap. 14. — Dionis, Anat. 3. demonstr.  
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equal distances, and the large *reservoirs* of blood, the *sinuses*, are under or near them. 5. That fractures might be prevented from reaching so far as they would in a continuous bony substance. 6. That the connection of the sutures being capable of yielding, the bones might be allowed to separate; which has given great relief to patients from the violent symptoms which they had before this separation happened (*a*). And it seems reasonable to believe, that the opening of the sutures was a great benefit to several others who were rather judged to have been hurt by it (*b*): for we must think, that the consequences of such a force acting upon the brain, as was capable of thrusting the bones asunder, must have been fatal, unless it had been thus yielded to.

Having gone through the general structure of the *cranium*, I now proceed to examine each bone of which that brain-case consists, in the order in which I first named them.

The *OS FRONTIS* † has its name from being the only bone of that part of the skull we call the *forehead*, though it reaches a good deal further. It has some resemblance in shape to the shell of the *concha bivalvis*, common

(*a*) Ephemerid. Germanic. dec. 1. ann. 4. et serv. 33.

(*b*) Ephemerid. Germ. dec. 2. ann. 9. obs. 230. cent. 10. obs. 37. — Vander Linden Medicin. phys. cap. art. 4. § 16. — Hildan. Observ. cent. 1. obs. 1. cent. obs. 7. — Bauhin. Theat. anat. lib. 3. cap. 6. — Perthes Observ. lib. 2. observ. 39.

† Μετωρύον, Βρίγμα, coronale, inverecundum, puppis communis, fincipitis.

led the *cockle*; for the greatest part of it is convex externally, and concave internally, with a serrated circular edge; while the smaller part has processes and depressions, which make of an irregular figure.

The external surface of the *os frontis* is smooth on its upper convex part; but several processes and cavities are observable below: for, at each angle of each orbit, the bone juts out to form four processes, two internal, and a large one external; which, from this situation, may well enough be named *angular*. Between the internal and external angular processes on each side, an arched ridge is extended, on which the eye brows are placed.—Very little above the internal end of each of these *superciliary* ridges, a protuberance may be remarked, in almost all skulls, where there are large cavities, called *sinuses*, within the bone; of which hereafter.—Betwixt the internal angular processes, a small process rises, which forms some share of the bridge of the nose, and thence is named *nasal*.—Some also serve a protuberant part on the edge of the bone behind each external angular process, which they call *temporal* processes; but these are inconsiderable.—From the under part of the *superciliary* ridges, the frontal bone runs a great way backwards; which parts may justly enough be called *orbital* processes. These, contrary to the rest of this bone, are concave internally, for receiving the globes of the eyes, with their muscles, fat, &c.

In each of the *orbital* processes, behind the middle of the *superciliary* ridges, a considerable sinuosity is observed, where the *glandula*



*innominata Galeni* or *lachrymalis* is lodged.—Behind each internal angular process, a small pit may be remarked, where the cartilaginous pulley of the *musculus obliquus major* of the eye is fixed.—Betwixt the two orbital processes there is a large discontinuation of the bone into which the cribriform part of the *os ethmoides* is incased.—The frontal bone frequently has little caverns formed in it here where it is joined to the ethmoid bone.—Behind each external angular process, the surface of the frontal bone is considerably depressed where part of the *temporal* muscle is placed.

The *foramina*, or holes, observable on the external surface of the frontal bone, are three in each side.—One in each superciliary ridge, a little removed from its middle towards the nose; through which a twig of the ophthalmic branch of the fifth pair of nerves passes out of the orbit, with a small artery from the internal carotid, to be distributed to the teguments and muscles of the forehead.—These vessels in some skulls make furrows in the *os frontis*, especially in the bones of children, as has also been observed of another considerable vessel of this bone near its middle (a) and therefore we ought to beware of transverse incisions on either side of the *os frontis*; which might either open these vessels or hurt the nerves while they are yet in part within the bone; for when vessels are thus wounded, it is difficult to stop the hæmorrhagy, because the adhesion of a part of the artery to the bone hinders its contraction.

(a) Ruyfch. Mus. anat. theca D. deposit, 4. No. 3.

contraction, and consequently styptics can have little effect; the sides of the furrow keep off compressing substances from the artery; and we would wish to shun cauteries or escharotics, because they make the bone carious; and lacerations, when thus hurt, sometimes produce violent symptoms.—But, to return to the *superciliary foramina*, we must remark, that often, instead of a hole, a notch only is to be seen: nay, in some skulls, scarce a vestige even of this is left; in others, both hole and notch are observable, when the nerve and artery run separately. Frequently a hole is found on one side, and a notch on the other; at other times we see two holes; or there is a common hole without, and two distinct entries internally. The reason of this variety of a hole, notch, depression, or smoothness in the superciliary ridge, is the different length and tension of the nerves and vessels; the shorter they are, the more they are sunk into the bone, and it grows.—Near the middle of the inside of each orbit, hard by, or in the *transverse suture*, there is a small hole for the passage of the nasal twig of the first branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. This hole is sometimes entirely formed in the *os frontis*; in other skulls, the sides of it are composed of this last bone, and of the *os planum*. It is commonly known by the name of *orbitarium internum*, though *anterius* should be added, because of the next, which is commonly omitted.——This, which may be called *orbitarium internum posterius*, is such another as the former; only smaller, and about an

inch deeper in the orbit: through it a small branch of the ocular artery passes to the nose.—Besides these six, there are a great number of small holes observable on the outer surface of this bone, particularly in the two protuberances above the eye brows. Most of these penetrate no further than the *sinuses*, or than the *diploe*, if the *sinuses* are wanting; though sometimes I have seen this bone so perforated by a vast number of these small holes, that placed between the eye and a clear light, it appeared like a sieve.—In the orbit of the generality of *skeletons*, we may observe one, two or more holes, which allow a passage to a hog-bristle through the skull. The place, size, and number of these, are however uncertain: They generally serve for the transmission of small arteries or nerves.

The internal surface of the *os frontis* is concave, except at the orbital processes, which are convex, to support the anterior lobes of the brain. This surface is not so smooth as the external; for the larger branches of the arteries of the *dura mater* make some furrows in its sides and back parts. The sinuosities from the luxuriant risings of the brain, mentioned when describing the general structure of the *cranium*, are often very observable on its upper part, and its lower and fore parts are marked with the contorsions of the anterior lobes of the brain.—Through the middle of this internal surface, where always in children, and sometimes in old people, the bone is divided, either a ridge stands out, to which the upper edge of the *falx* is fastened, or a furrow runs, which

which the upper side of the superior longitudinal *sinus* is lodged; on both these accounts chirographical authors justly discharge the application of the trepan here.—The reason of this difference in skulls, is alledged by some authors to be this, That in thin skulls the ridge lengthens the bones, and in thick ones there is no occasion for it. To this way of account, for this phænomenon, it may justly be objected, that generally very thick skulls have a large spine here, and frequently thin ones have only a furrow. Perhaps this variety may be owing to the different times of compleat ossification of those parts in different subjects: if the two sides of this bone meet before they arrive at their utmost extent of growth, they unite very firmly, and all their fibres endeavour to stretch themselves out: where the resistance is, that is, between the hemispheres of the brain. To support this reason, we may remark, that those adults, whose frontal bone is divided by the sagittal suture, never have a ridge in this place.

Immediately at the root of this ridge or suture there is a small hole, which sometimes passes through the first table, and, in other cases, opens into the superior *sinus* of the ethmoidal bone within the nose. In it a little process of the *falx* is lodged, and a small artery, sometimes a vein, runs (*a*); and the superior longitudinal *sinus* begins here.—This hole, however, is often not entirely proper to the os; for in several skulls, the lower part of it is formed in the upper part of the base of the

*crista*

Morgagn. *Adversar.* 6. animad. 31.



*crista galli*, which is a process of the *ethmoidal* bone (a).

The *os frontis* is composed of two tables and an intermediate *diploe*, as the other bones of the *cranium* are, and, in a middle degree of thickness between the *os occipitis* and the *parietal* bones; is pretty equally dense all through except at the orbital processes, where, by the action of the eye on one side, and pressure of the lobes of the brain on the other, it is made extremely thin and diaphanous, and the *nitellium* is entirely obliterated. Since in this place there is so weak a defence for the brain the reason appears why fenceers esteem a wound in the eye mortal (b).

The *diploe* is also exhausted in that part above the eye-brows, where the two tables of the bone separate, by the external being protruded outwards, to form two large cavities called *sinus frontales*.—These are divided by a middle perpendicular bony partition.—The capacities in the same subject are seldom equal, in some the right, in others the left is largest. And in different bones their size is as inconsistent; nay, I have examined some, where they were entirely wanting; which oftener happens in such as have a flat fore-head, and whose *frontal* suture is continued down to the nose than in others. (c).—In some skulls, besides a large perpendicular *septum*, there are several

(a) Ingrass. Comment. in Galen. de ossib. cap. 1. comment. 8.

(b) Ruysch. Observ. anat. chir. observ. 54. — Diemerbroeck. Anat. lib. 3. cap. 10. — Bonet. Sepulch. anat. lib. 4. observ. 17.

(c) Fallop. Exposit. de ossibus, cap. 13.

ny pillars, or short partitions, found in each  
 s; in others these are wanting.—For the  
 st part the *septum* is entire; at other times  
 s discontinued, and the two *sinuses* commu-  
 ate.—When the *sinuses* are seen in such skulls  
 have the frontal bone divided by the sagittal  
 are, the partition dividing these cavities is  
 dently composed of two plates, which easily  
 arate.—Each *sinus* commonly opens by a  
 ndish small hole, at the inner and lower part  
 the internal angular processes, into a *sinus*  
 med in the nose, at the upper and back part  
 the *os unguis*; near to which there are also  
 he other small *sinuses* of this bone (*a*), the  
 ater part of which open separately nearer  
*septum narium*, and often they terminate in  
 same common canal with the large ones.

n a natural and sound state, these cavities  
 of considerable advantage; for the organ  
 smelling being thus enlarged, the *effluvia*  
 odorous bodies more difficultly escape it;  
 their impressions being more numerous, are  
 refore stronger, and affect the organ more.  
 at odorous particles may be applied to the  
 mbrane of the *sinuses*, is evident from the  
 felt in this part of the forehead, when the  
*via* of volatile spirits, or of strong aroma-  
 are drawn up into the nose by a quick  
 iration.—These and the other ca-  
 es which open into the nose, increase the  
 d of our voice, and render it more melo-  
 as, by serving as so many vaults to resound  
 notes. Hence people labouring under a  
 za, or stoppage of the nose from any o-  
 ther

Cowper in Drake's *Anthropolog* book 3. chap. 10.

ther cause, when they are by the vulgar, though falsely, said to speak through their nose, have such a disagreeable harsh voice.——The liquor separated in the membrane of these sinuses drills down upon the membrane of the nose, to keep it moist.

From the description of these *sinuses*, it is evident, how useless, nay, how pernicious must be, to apply a trepan on this part of the skull; for this instrument, instead of piercing into the cavity of the *cranium*, would reach no further than the *sinuses*; or, if the inner table was perforated, any extravasated blood that happened to be within the skull, would not be discharged outwardly, but would fall into the *sinuses*, there to stagnate, corrupt, and stimulate the sensible membranes; from which there would be such a constant flow of glaucous mucus, as would retard, if not hinder a cure, and would make the sore degenerate into an incurable *fistula*. Besides, as it would be almost impossible in this case to prevent the air from passing through the nose, from having constant access to the *dura mater*, or brain; but a corruption would be brought on these parts, as would be attended with great danger. Further, in respiration, the air rushing violently into these cavities of the *os frontis*, and passing through the external orifice, whenever it was not well covered and defended, would not only prevent the closing up of the external orifice, but might otherwise bring on bad consequences (a).——The membrane lining the

(a) Paaw, de Ossibus, pars. 1. cap. 7.——Palsyne Anatomie, traité 4. chap. 23. Nouvelle osteologie, partie 2. chap.

ses is so sensible, that inflammations of it create violent torture (a) ; and worms, or other insects crawling there, must give great uneasiness (b).

The upper circular part of the *os frontis*, is joined to the *ossa parietalia*, from one temple to the other, by the coronal suture. From the termination of the coronal suture to the external angular processes, this bone is connected to the *sphenoid* by the *sphenoidal* suture. At the external *canthi* of the eyes, its angular processes are joined by the transverse suture to the *malarum*, to which it adheres one third on the outside of the orbits ; whence to the bottom of these cavities, and a little up on their internal sides, these orbital processes are connected to the *sphenoidal* bone by that same suture.—In some few skulls, however, a discontinuation of these two bones appears at the lower part of the long slit, near the bottom of the orbit. — On the inside of each orbit, the orbital process is indented between the *cribriform* part of the *ethmoid* bone, and the *os unguis*. — The transverse suture afterwards joins the frontal bone to the superior processes of the *ossa maxillaria superiora*, and to the nasal bones. And, *lastly*, its nasal process is connected to the nasal *lamella* of the *sphenoid* bone.

The

(a) Fernel. Partholog. lib. 5. cap. 7. — Saltzman Decur. v. 10.

(b) Fernel. Partholog. lib. 5. cap. 7. — Bartholin. Epistol. c. cent. 2. epist. 74. — Hist. de l'acad. des sciences, & 1733.



The *frontal* bone serves to defend and support the anterior lobes of the brain. It forms a considerable part of the cavities that contain the globes of the eyes, helps to make up the *septum narium*, organ of smelling, &c. From the description of the several parts, the other uses of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the superciliary holes are not formed; often a small round piece of the orbital process, behind the superciliary ridge is not ossified, and there is no *sinus* to be found within its substance.

Each of the two *OSSA PARIETALIA* or bones serving as walls to the *encephalon* is an irregular square; its upper and fore side being longer than the one behind or below. The inferior side is a concave arch; the middle part receiving the upper round part of the temporal bone.—The angle formed by this upper side, and the fore one, is so extended, as to have the appearance of a process.

The external surface of each *os parietale* is convex. Upon it, somewhat below the middle height of the bone, there is a transverse raised ridge, of a whiter colour generally than any other part of the bone; from which arise bones that have strong prints of muscles, we see a great many converging furrows, like many *radii* drawn from a circumference towards a center. From this ridge of each the temporal muscle rises; and, by the pressure of its fibres, occasions the furrows just mentioned.

• Κορυφή, paria, sincipitis, verticis, arcualia, nervationis, rationis, bregmatis, madefactionis.

tioned.—Below these, we observe, near semicircular edges, a great many risings depressions, which are joined to like inequalities on the inside of the temporal bone, form the squamous suture. The temporal may therefore serve here as a buttress, to prevent the lower side of the parietal from being outwards when its upper part is pressed back (*a*).

Near the upper sides of these bones, towards the hind part, is a small hole in each, through which a vein passes from the teguments of the skull to the longitudinal *sinus*. Sometimes I have seen a branch of the temporal artery pass through this hole, to be distributed to the upper part of the *falx*, and to the *dura mater* on its sides, where it had frequent anastomoses with the branches of the arteries descending from the external carotids, which commonly have the name of the arteries of the *dura mater*, and with the branches of the internal carotids which serve the *falx*.—In several skulls, one of the *ossa parietalia* has not this hole; in others, there are two in one bone; in some not one in either. Most frequently the hole is through both tables; at other times the external table is only perforated.—This knowledge of the course of these vessels, may be of use to surgeons, when they make an incision near this part of the head, lest, if the vessels are rashly cut near the hole, they bleed within the substance of the bone, and cause an obstinate hæmorrhagy, which neither ligatures nor medicines can stop.

H

On

Hunauld in Mem. de l'acad. des sciences, 1730.

On the inner concave surface of the parietal bones, we see a great many deep furrows disposed somewhat like the branches of trees. The furrows are largest and deepest at the lower edge of each *os parietale*, especially at its anterior angle, where sometimes a full canal is formed. They afterwards divide into small furrows, in their progress upwards. In some skulls a large furrow begins at a hole near the upper edge, and divides into branches, which join with those which come upwards, shewing the communications of the upper and lower vessels of the *dura mater*. In these furrows we frequently see passages to the *diploe*; and sometimes I have observed canals going off, which allowed a small part to pass some inches into the bony substance. Some (a) tell us, that they have observed canals piercing the bone towards the occiput. On the inside of the upper edge of the *parietalia*, there is a large sinuosity, frequently larger in the bone of one side than of the other, where the upper part of the *falx* is lodged, and the superior longitudinal sinus is lodged.—Generally part of the lateral sinus makes a depression near the angle, forming the lower and posterior sides of these bones, and the pits made by the prominent parts of the brain are to be seen in no part of the bone more frequent, or more considerable, than on the internal surface of the parietal bones.

The *ossa parietalia* are amongst the thin bones of the *cranium*; but enjoy the general structure

(a) Cowper. Anatom. explic. of 90. tab. fig. 2.

ture of two tables and *diploe* the compound, and are the most equal and smooth.

These bones are joined at their fore-side to *os frontis* by the coronal suture; at their inferior angles, to the *sphenoid bone*, by the suture of this name; at their lower edge, to the *ossa temporum*, by the squamosal suture, and its posterior *additamentum*; and, to the *os occipitis*, or *ossa triquetra*, by the lambdoid suture; and above, to one another by the sagittal suture.

They have no particular uses besides those mentioned in the description of their several parts, except what are included in the account of the general structure of the *cranium*.

In a child born at the full time, none of the sutures of this bone are completed; and there is a hole in the ossified part of it near to the sagittal suture.

The large unossified ligamentous part of the *cranium* observable between the parietal bones, in the middle of the divided *os frontis* of unborn children, called by the vulgar the *fontanelle of the head*, was imagined by the ancients to serve for the evacuation of the superfluous moisture of the brain; and therefore named it *bregma* \*, or the fountain; sometimes adding the epithet *pulsatilis*, or beating, on account of the pulsation of the brain through this flexible ligamento-cartilaginous substance. Hence very frequently the parietal bones are called *ossa bregmatis*.

The upper middle part of the head of a child, in a natural birth, being what presents itself.

H 2

itself.

*Alpitans vertex, foliolum, folium, triangularis lacuna.*



itself first at the *os uteri* (a), an accoucheur may reach the *bregma* with his finger, when the *os uteri* is a little opened. If the *bregma* is stretched, and the pulsation of the brain felt through it, the child is certainly alive. But if it is shrivelled and flaccid, without any observable pulsation in it, there is some reason to suspect the child to be very weak, or dead. Those who practise midwifery should therefore examine the state of the *bregma* accurately.

All the *bregma* is generally ossified before seven years of age. Several authors (b) say they have observed it unossified in adults; and physicians, who order the application of medicines at the meeting of the coronal and fontal sutures, seem yet to think that a detraction of noxious humours from the *encephalon* more easily procured at this part than any other of the skull; and that medicines have greater effect here, than elsewhere, in the internal disorders of the head.

*OSSA TEMPORUM* \*, so named by several authors, from the hair's first becoming long on the temples, and thus discovering people of different ages, are each of them equal and smooth above, with a very thin semicircular edge, which, from the manner of its connection with the neighbouring bones, is distinguished by

(a) Burton's Midwifery, § 51. — Smellie's Midwifery, book 1. chap. 1. § 5.

(b) Bartholin. Anat. reform. lib. 4. cap. 6. — Dieb. broek, Anat. lib. 9. cap. 6. — Kerkring. Osteogen. cap. 1.

\* *Κόρταρων*, *κορσῶν*, *κορῶν*, *λεπιδοειδῶν*, *πολυιδῶν*, *λιθωειδῶν*, *temporalia*, *lapidosa*, *mendosa*, *dura*, *arcualia*, *tympanum*, *parietalia*, *faxea*, *parietalia*.

ne of *os squamosum*.—Behind this, the upper part of the temporal bone is thicker, and is unequal, and is sometimes described as a distinct part, under the name of *pars mammillaris* (a).—Towards the base of the skull, the temporal bone appears very irregular and unequal; and this part, instead of being broad, is placed perpendicularly, as the others are, is contracted into an oblong very hard substance, extended horizontally forwards and inwards, which in its progress becomes smaller, and is commonly called *os petrosum*.

Three external processes of each temporal bone are generally described—The first placed at the lower and hind part of the bone, from its resemblance to a nipple, is called *mastoides*, *mammillaris*. It is not solid, but within is composed of *cancelli*, or small cells, which permit a communication with the large cavity of the ear, the drum; and therefore sounds, being multiplied in this vaulted labyrinth, are increased, before they are applied to the immediate organ of hearing. Into the mastoid process, the *sternomastoideus* muscle is inserted; and to its back part, where the surface is rough, the *trachelomastoideus*, and part of the *splenius* are fixed.—About an inch farther forward, the second process begins to rise out from the bone; and having its origin continued obliquely downwards and forwards for some way, it becomes smaller, and is stretched forwards to join with the *os male*; they together forming the bony *jugum*, under which the temporal muscle passes.

H 3

Hence

(a) Albin de ossib. § 26.

Hence this process has been named *zygomatic*. Its upper edge has the strong aponeurosis of the *temporal* muscle fixed into it; and its lower part gives rise to a share of the *masseter*.—

The fore-part of the base of this process is an oblong tubercle, which in a recent subject is covered with a smooth polished cartilage continued from that which lines the cavity immediately behind this tubercle.——from the

under craggy part of the *os temporum*, the third process stands out obliquely forward.

The shape of it is generally said to resemble the ancient *stylus scriptorius*; and therefore is called the *styloid* process †. Some authors

however contend, that it ought to be named *steloïd*, from its being more like to a pillar.

Several muscles have their origin from the process, and borrow one half of their name

from it; as *stylo-glossus*, *stylo-hyoideus*, *stylo-pharyngeus*; to it a ligament of the *os hyoidæ*

is sometimes fixed; and another is extended from it to the inside of the angle of the lower jaw.

This process is often even in adults not entirely ossified, but is ligamentous at its root, and sometimes is composed of two

three distinct pieces.——Round the root of it especially at the fore-part, there is a remarkable rising of the *os petrosum*, which some

have esteemed a process; and, from the appearance

\* Καγκρος, *paris*, *ansæ ossium temporum*, *ossa arcualia*, *ia*, *jugalia*, c. *njugalia*.

† Γραιφοειδῆ, βελονοειδῆ, πλῆκτρον, *os calaminum*, *figula*, *clavale*, *acuale*, *calcar capitis*.

(a) Galen, de usu part. lib. 2, cap. 4 — Fallop. *Obs. anat.*

rance it makes with the *styloform*, have named it *vaginalis*.—Others again have, under the name of *auditory* process, reckoned among the external processes that semicircular ridge, which, running between the root of the *maxillary* and *zygomatic* processes, forms the under-surface of the external *meatus auditorius*.

The sinuosities or depressions on the external surface of each *os temporum* are these :—A long *fossa* at the inner and back part of the root of the maxillary process, where the anterior head of the *digastric* muscle has its origin. — Immediately before the root of the *zygomatic* process, a considerable hollow is left, lodging the *crotaphite* muscle.—Between the *zygomatic*, *auditory*, and *vaginal* processes, a large cavity is formed ; through the middle of which, from top to bottom, a fissure is observable, into which part of the ligament that secures the articulation of the lower jaw with this bone is fixed. The fore part of the cavity being lined with the same cartilage which covers the tubercle before it, receives the *condyle* of the jaw ; and in the back part a small share of the parotid gland, and a small fatty substance, are lodged.—At the inner end of the root of the *styloid apophyse*, there is a gimble-like cavity, where the beginning of the internal jugular vein, or end of the lateral carotid artery is lodged.—And as the sinuses of the two bones are frequently of unequal size ; so one of the cavities is as often larger than the other (*a*).—Round the external *meatus auditorius*, several sinuosities are formed for receiving the cartilages

(a) Hanauld. in Mem. de l'acad. des sciences, 1730.



tilages and ligaments of the ear, and for their firm adhesion.

The *holes* that commonly appear on the outside of each of these bones, and are proper to each of them, are five.—The *first*, situated between the *zygomatic* and *mastoid* processes, is the orifice of a large funnel-like canal which leads to the organ of hearing; therefore is called *meatus auditorius externus* \*.—The *second* gives passage to the *portia dura* of the seventh pair of nerves, and from its situation between the *mastoid* and *styloid* processes, is called *foramen stylo-mastoideum* †.—Some before, and to the inside of the *styloid* process, is the *third* hole; the canal from which runs upwards, then forwards, and receives into it the internal *carotid* artery, and the beginning of the intercostal nerve; where this canal is about to make the turn forwards, one, or sometimes two very small holes go off towards the cavity of the ear called *tympanum*: through these *Valsalva* (a) affirms the proper arteries of that cavity are sent.—On the anterior edge of this bone, near the former, a fourth hole is observable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the *tympanum*. This, in the recent subject, is continued forward and inward, from the parts which I mentioned just now as its orifice in the skeleton, to the side of the nostrils; being partly cartilaginous, and partly ligamentous.

\* Πόρος της ακοῆς, πρὸ τῶν ὠτῶν, fenestra aurium.

† Aquæductus Fallopii.

(a) De aure humana, cap. 2. § 22. et tab. 7. fig. 1.

hole canal is named, *Iter a palato ad aurem*, or *flachian tube*.—On the external side of the any part of this canal, and a top of the chink the cavity that receives the *condyle* of the lower jaw, is the course of the little nerve commonly to be reflected from the lingual branch of the fifth pair, till it enters the *tympanum*, to run across this cavity, and to have the name of *chorda tympani*.—The fifth hole very uncertain, appearing sometimes behind the *mastoid* process; sometimes it is common to the temporal and occipital bones; and in several skulls there is no such hole. The use of it, when found, is for the transmission of a vein from the external teguments to the internal *sinus*: But, in some subjects, a branch of the occipital artery passes through this hole, to serve the back part of the *dura mater*; in others, I have seen two or three such holes: but they are oftener wanting than found. And I may, once for all, in general remark, That the largeness, number, situation, and existence of all such holes, that for the most part allow only a passage for veins from without to the internal receptacles, are very uncertain. The internal surface of the *os temporum* is unequal; the upper circular edge of the squamous part having numerous small ridges and furrows for its conjunction with the parietal bones; and the rest of it is irregularly marked with the convolutions of the middle part of the brain, and with furrows made by the branches of the arteries of the *dura mater*. From the under part of this internal surface, a larger transverse hard craggy protuberance runs

runs horizontally inwards and forwards, with a sharp edge above, and two flat sides, one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between these two sides, the large lateral process of the *dura mater* is fixed.

Sometimes a small bone, a-kin to the sphenoid, is found between the small end of the *petrous* process and the *sphenoid* bone (a).

Towards the back-part of the inside of the *os temporum*, a large deep *fossa* is conspicuous where the *lateral sinus* lies; and frequently on the top of the *petrous* ridge, a furrow may be observed, where a small sinus is situated.

The internal proper *foramina* of each of these bones are, *first*, the internal *meatus auditorius* in the posterior plain side of the *petrous* process. This hole soon divides into two, one of which is the beginning of the *aqueduct of Fallopius*; the other ends in several very small canals (b) that allow a passage to the branches of the *portio mollis* of the seventh pair of nerves, into the *vestibule* and *cochlea*. Through it also an artery is sent, to be distributed to the organ of hearing. — The *second* hole, which is on the anterior plain side of the craggy process, gives passage to a reflected branch of the second branch of the fifth pair of nerves, which joins the *portio dura* of the auditory nerve, while it is in the *aqueduct* (c).

(a) Riolan. Comment. de ossib. cap. 32. — Windt. Exposition anatomique de corps humain, trait. des os fac. § 266.

(b) Valsalv. De aure humana, cap. 3. § 11.

(c) Valsalv. De aurg. cap. 3. § 10.

all branches of blood vessels accompanying the nerves or passing through smaller holes than this one.—The passage of the cutaneous into the lateral *sinus*, or of a branch of the occipital artery, is seen about the middle of the large *fossa* for that *sinus*; and the orifice of the canal of the *carotid* artery is evident at the under part of the point of the *petrous* process.

Besides these proper holes of the temporal bones which appear on their external and internal surfaces, there are two others in each side that are common to this bone and to the *occipital* and *sphenoidal* bones; which shall be mentioned afterwards in the description of these bones.

The upper round part of the squamous bones is thin, but equal; while the low petrous part is thick and strong, but irregular and unequal, forming the distinction of *tables* and *diploe* founded, with several cavities, processes, and bones within its substance, which are parts of the organ of hearing. That a clear idea may be had of this beautiful, but intricate organ, anatomists generally chuse to demonstrate its parts together. I think the method is good; and therefore, since it would be improper to insert a compleat treatise on the ear, I shall omit the description of the parts contained within the *os petrosum* of the skele-

The temporal bones are joined above to the facial bones by the squamous sutures, and their posterior *additamenta*: Before, to the *sphenoidal* bone by the suture of that name; to the cheek-



cheek-bones by the *zygomatic* sutures : Behind to the *occipital* bone, by the *lambdoid* suture and its *additamenta* ; and they are articulated with the *lower jaw* in the manner which shall be described when this bone is examined.

The purposes which these two bones serve are easily collected, from the general use of the *cranium*, and from what has been said in the description of their several parts.

In an infant, a small fissure is to be observed between the thin upper part, and the lower craggy part of each of these bones ; which points out the recent union of these parts.—Neither *mastoid* nor *styloid* processes are yet to be seen.—Instead of a bony funnel-like external *meatus auditorius*, there is only a smooth bony ring, within which the membrane of the drum is fastened.—At the entry of the *Eustachian tube*, the side of the *tympanum* is not completed.—A little more outward than the internal auditory canal, there is a deep pit, over the upper part of whose orifice the interior semicircular canal of the ear is stretched ; and some way below this, the posterior semicircular canal also appears manifestly.

*OS OCCIPITIS* \*, so called from its situation, is convex on the outside, and concave internally. Its figure is an irregular square, rather *rhomboid* ; of which the angle above is generally a little rounded ; the two lateral angles are more finished, but obtuse ; and the lower one is stretched forward in form of a wedge, and thence is called by some the *condylar*

\* "Ἰψον, basilare, proræ, memoriæ, pixidis, fibrosum, notum, lambde.

process. — If one would, however, be very  
in observing the several turns which the  
es of the *os occipitis* make, five or seven  
s and as many angles of this bone might  
described.

The external surface is convex, except at  
cuneiform apophyse, where it is flatted. At  
base of this triangular process, on each side  
the great hole, but more advanced forwards  
in the middle of it, the large oblong protu-  
ances, named the *condyles*, appear, to serve  
the articulation of this bone with the  
*vertebra* of the neck. The smooth surface  
each of these *condylaid* processes is longest  
behind forwards, where, by their oblique  
tion, they come much nearer to each o-  
than they are at their back part. Their  
sides are lower than the external, by  
which they are prevented from sliding to either  
out of the cavities of the first *vertebra* (a).  
On some subjects each of these plain smooth  
aces seems to be divided by a small rising  
its middle; and the lower edge of each  
yle, next the great *foramen*, is disconti-  
about the middle, by an interveening  
h: Whence some (b) alledge, that each of  
*apophyses* is made up of two protuberan-  
—Round their root a small depression and  
gy roughness is observable, where the li-  
ents for surrounding and securing their ar-  
ations adhere. — Though the motion of the  
is performed on the condyles, yet the  
er of gravity of that globe does not fall

I

between

Galen. de usu part lib. 12. cap. 7:  
Diemerbroeck, Anat. lib. 9. cap. 6.

between them, but is a good way further forward; from which mechanism it is evident that the muscles which pull the head back must be in a constant state of contraction, which is stronger than the natural contraction of the proper flexors, else the head would always fall forwards, as it does when a man is asleep, or labours under a palsy, as well as in infants, where the weight of the head far exceeds the proportional strength of these muscles. This seeming disadvantageous situation of the condyles is however of good use to the head by allowing sufficient space for the cavities of the mouth and *fauces*, and for lodging a sufficient number of muscles; which commonly are directed to act on the head, and then have an advantageous lever to act with, so as to be able to sustain a considerable weight appended, or other force applied, to pull the head back.

Somewhat more externally than the condyles there is a small rising and semilunated hollow in each side, which make part of the base common to the *occipital* and *petrous* bones.—Immediately behind this, on each side, a scabrous ridge is extended from the middle of the condyle, towards the root of the *mastoid* process. Into this ridge the *musculus lateralis*, commonly ascribed to *Fallopian*, is inserted.—About the middle of the external convex surface, a large arch runs cross the bone; from the upper lateral parts of which the *occipital* muscles take their rise; to its middle the *trapezii* are attached; and half way between this and the great hole, a lesser arch is extended.—In

ows between the middle of these arches *complexi* are inserted; and in the depression more external and further forward than, the *splenii* are inserted.—Between the middle of the lesser arch and the great hole, little hollow marks of the *recti minores* appear; and on each side of these the fleshy insertions of the *obliqui superiores* and *recti majores* make depressions.—Through the middle of two arches a small sharp *spine* is placed, which serves as some sort of partition between muscles of different sides, or rather is owing to the action of the muscles depressing the bone on each side of it, while this part is free from their compression.—These prints of the muscles on this bone are very strong and plain in some subjects, but are not so distinct in others.—All round the great *foramen* the edges are unequal, for the firmer adhesion of the circular ligament which goes thence to the next *vertebra*.—One end of each *lateral* or *rotator* ligament of the head, is fixed to a rough surface at the fore-part of each condyle, the *perpendicular* one is connected to a rough surface of the edge of the great hole between the condyles.—Immediately before the condyles two little depressions are made in the external surface of the cuneiform process, for the insertion of the *recti anteriores minores* muscles, which are unjustly ascribed to *Cowper*: and still further forward, near the *sphenoid* bone, are other such depressions, for the reception of the *recti anteriores majores*.—When we consider the size of the prints of muscles on the



occipital bone, before and behind its condyles and at the same time, compare their distances from these centers of motion of the head, we must see how much stronger the muscles which pull the head backwards, than those which bend it forward; and how much greater force the former acquire by the long lever they act with, than the latter which are inserted so near the condyles. This great force of the extensor muscles is altogether necessary that they might not only keep the head from falling forward in an erect posture, but that they might support it when we bow forward in the most necessary offices of social life, when the weight of the head comes to act at right angles on the *vertebra* of the neck, and obtains a long lever to act with.

On the inner surface of the *os occipitis* we see two ridges; one standing perpendicular, the other running horizontally across the bone. The upper part of the perpendicular limb of the cross, to which the *falx* is fixed, is hollowed in the middle, or often on one side, for the reception of the *superior longitudinal sinus*, and the lower part of it has the small or inferior process of the *dura mater* fastened to it, and is sometimes hollowed by the *occipital sinus*. Each side of the horizontal limb is made hollow by the lateral sinuses inclosed in the transverse process of the *dura mater*; the *fossa* in the right side being generally a continuation of the one made by the longitudinal sinus in the perpendicular limb, and therefore is larger than the left one (a).—Round the middle of

(a) Morgagni. *Advers. anat.* 6. animad. 1.

There are four large depressions separated by its limbs; the two upper ones being formed by the back part of the brain, and the lower ones by the *cerebellum*.—Farther forward than the last mentioned depressions, is the lower part of the *fossa* for the lateral *sinus* on each side.—The inner surface of the superior apophyse is made concave for the reception of the *medulla oblongata*, and of the vertebral artery.—A furrow is made on each side, along the edges of this process, by a *sinus* of the *dura mater*, which empties itself into the lateral *sinus* (b).

The holes of this bone are commonly five on each side, and two common to it and to the temporal bones.—The first of the proper holes, called *foramen magnum* \* from its size, is immediately behind the wedge-like process, and serves as a passage to the *medulla oblongata*, *nervi accessorii*, to the vertebral arteries, and sometimes to the vertebral veins.—At each angle of this great hole, near its fore-part, and immediately above the condyles, we always find a hole, sometimes two, which soon unite into one that opens externally; thro' these twelfth pair of nerves go out of the skull.—The fourth and fifth holes pierce from behind the condyle of each side into the *fossa* of the lateral *sinuses*; they serve for the passage of the vertebral veins to these *sinuses*. Often one of these holes is wanting, sometimes both, and the veins pass thro' the great *foramen*.—Near these five, we frequently meet with other holes near the edges of this bone, for the

I 3

transmissio

Albin. de ossib. § 65.

Epilepsia, Medullæ spinalis.

transmission of veins; but their number and diameter are very uncertain. The two common *foramina* are the large irregular holes, one in each side, between the sides of the *petrosiform* process, and the edges of the *petrosal* bones. In a recent subject, a strong membrane runs cross from one side to the other of each of these holes; in some heads I have seen the membrane ossified, or a bony partition dividing each hole; and, in the greater number of adult skulls, there is a small sharp pointed process stands out from the *os petrosum*, and a more obtuse rising in the occipital bone, between which the partition is stretched. Behind this partition, where the largest space is, the *lateral sinus* has its passage; and before the eighth pair of nerves and *accessorius* make their exit out of the skull; and some authors say, an artery passes through this hole, to be flowed on the *dura mater*.

The *occipital* bone is among the thickest of the *cranium*, though unequally so; for it is stronger above, where it has no other defence than the common teguments, than it is below, where being pressed by the lobes of the *hemispheres* and *cerebellum* on one side, and by the action of the muscles on the other, it is so very thin as to be diaphanous in many skulls: But these muscles ward off injuries, and the ribs and spines, which are frequent here, make it sufficiently strong to resist ordinary force. The tables and *diploe* are tolerably distinct in this bone, except where it is so thin as to become diaphanous.

The occipital bone is joined above to the *os parietalia* and *triquetra* when present, by the *lambdoid* suture;——laterally to the temporal bones, by the *additamenta* of the *lambdoid* suture;——below to the *sphenoid* bone, by the process of its cuneiform process, in the same way the epiphyses and their bones are joined: For in children a ligamentous cartilage is interposed between the occipital and sphenoid bones, which gradually turns thinner, as each of the bones advances, till their fibres at last run in each other; and, about sixteen or eighteen years of age, the union of these two bones becomes so intimate, that a separation cannot be made without violence.——The *os occipitis* is joined by a double articulation to the first *vertebra* of the neck, each condyle being received into a superior oblique process of that *vertebra*. What motion is allowed here, we consider afterwards, where the *vertebrae* are described.

The uses of this bone appear from the preceding description, and therefore need not be repeated.

An infant born at the full time, has this bone divided, by unossified cartilages, into four pieces.——The first of these is larger than the other three, is of a triangular shape, and contains all the part of the bone above the *foramen*. Generally fissures appear in the upper part and sides of this triangular bone, and all the cartilage is separated by maceration, and sometimes little distinct bones are found towards the edges of it.—The second and third pieces of this bone are exactly alike, and are situated



situated on each side of the great foramen from which very near the whole condyles are produced; and they are extended forwards almost to the fore-part of the hole for the ninth pair of nerves.—The fourth piece is the coniform process, which forms a small share of the great hole, and of these for the ninth pair of nerves, and of the condyles: between the *sphenoid* bone, a cartilage is interposed.

Of the eight bones which belong to the *cranium*, there are only two which are not yet described, viz. the *ethmoid* and *sphenoid*. The first we already mentioned, in compliance to the generality of writers on this subject, as being common to the *cranium* and face, because they enter into the composition of both: but for the same reason might equally be used for calling the frontal bone a common one too. I shall however, pass any idle dispute about the propriety of ranging them, and proceed to examine the structure of the bones themselves.

*OS ETHMOIDES* \*, or the sieve bone, has got its name from the great number of small holes with which that part of it first taken notice of is pierced. When the bone is entire, the figure of it is not easily described; but, by a detail of its several parts, some idea may be afforded of the whole; therefore I shall distinguish it into the *criiform lamella* with its process, the *nasal lamella*, *cellula*, and *ossa spongiosa*.

The thin horizontal *lamella*, is all (except its back part) pierced obliquely by a great number of small holes, through which the

\* Cribiforme, σπινθηροειδές, spongiforme, cristatum.

ts of the olfactory nerves pass. In a recent  
ect, these holes are so closely lined by the  
mater, that they are much less conspicu-  
than in the *skeleton*.——From the middle  
he internal side of this plate, a thick pro-  
rises upwards, and, being highest at the  
part, gradually becomes lower, as it is  
ended backwards. From some resemblance  
h this process was imagined to have to a  
s comb, it has been called *crista galli* \*,  
*falx* is connected to its ridge, and to the  
erforated part of the cribriform plate.——  
en the *crista* is broke, its base is sometimes  
d to be hollow, with its cavity opening in-  
he nose (a).——Immediately before the  
est part of this process, is the blind hole  
he *frontal* bone, which as was formerly  
arked, is often in a good measure formed  
notch in the fore-part of the root of the

om the middle of the outer surface of the  
*cribriform lamella*, a thin solid plate is extend-  
ownwards and forwards, having the same  
mon base with the *crista galli*. Generally it  
ot exactly perpendicular, but is inclined to  
side or other, and therefore divides the ca-  
of the nose unequally. Its inclination to  
side, and flexure in the middle, is some-  
s so great, that it fills up a large share of  
of the nostrils, and has been mistook for  
pus. there.—It is thin at its rise, and ra-  
still thinner in its middle; yet afterwards,  
ards its lower edge, it becomes thicker,  
that

*Terruca praedura, septum ossis spongiosi.*

(a) *Falcyu Anat. chir. tr. 4. Cap. 44.*

that its conjunction with the bones and middle cartilage of the nose might be firmer.

At a little distance from each side of the external process, a cellular and spongy bone substance depends from the cribriform plate. The number and figure of the cells in this regular process of each side, are very uncertain, and not to be represented in words; only the cells open into each other, and into the cavity of the nose: The uppermost, which are below the aperture of the frontal *sinuses*, are formed like funnels.—The outer surface of these cells is smooth and plain, where this bone assists in composing the orbit; at which place on each side, it has got the name of *os planum*; on the upper edge of which, a sinus notch or two may sometimes be observed, which go to the formation of the internal orbital holes; as was remarked in the description of the frontal bone.

Below the cells of each side, a thin plate extended inwards, and then bending down, becomes thick and of a spongy texture.—This spongy part is triangular, with a straight upper edge placed horizontally, an anterior edge slanting from above, downwards and forwards, and with a pendulous convex one below.—The upper and lower edges terminate in a sharp point behind.—The side of this pendulous spongy part next to the *septum narium* is convex, and its external side is concave.—These processes of the *ethmoid* bone have got the name of *ossa spongiosa*, or *turbinata superiora*, from their substance, figure, and situation.

the prominences, cavities and *meanders* of this *ethmoid* bone, are covered with a continuation of the membrane of the nostrils, in the present subject. — Its horizontal cribriform plate is lodged between the orbital processes of the frontal bone, to which it is joined by the *ethmoid* suture, except at the back-part where it is connected with the *cuneiform* bone, by a suture common to both these bones, though generally esteemed part of the *sphenoid*.

Where the *ossa plana* are contiguous to the frontal bone within the orbit, their junction is reckoned part of the transverse suture. — Farther forward than the *ossa plana*, the cells are covered by the *ossa unguis*, which are not only contiguous to these cells, but can be separated from them, without breaking the bony substance; and therefore, in justice, these bones ought to be demonstrated as part of the *ethmoid* bone. — Below the *ossa unguis* and *ossa plana*, these cells and *ossa spongiosa* are occupied by the *maxillary* bones. — The cellular part of each *palate* bone is contiguous to the *os planum* and cells backwards. — The anterior edge of the nasal perpendicular plate is inserted into the furrow of the *vomer*. — Its superior edge is joined to the fore-part of the *processus azygos* of the *sphenoid* bone. — The upper edge joins the *nasal* process of the *maxilla* and *nasal* bones, and its anterior one is connected to the middle cartilage of the nose. From all which, the uses of this bone are evident, viz. to sustain the anterior lobes of the nose; to give passage to the olfactory nerves, to give attachment to the *falx*; to enlarge the organ



organ of smelling, by allowing the membrane of the nose a great extent; to straiten the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; to form a part of the orbit of the eyes and *septum narium*; while all its parts are so light as not to be in hazard of separating by their weight, and they are so thin, as to form a large surface without occupying much space. This brittle substance, however, is sufficiently protected from external injuries by the firm bones which cover it.

If this bone is seized on by any corrosive matter, we may easily conceive what destruction may ensue. Hence it is, that an *ozæna* is difficult to cure; and that, in violent *scorbutus* or in the *lues venerea*, the fabric of the nose, the eyes, and life itself are in danger.—The situation of the nasal plate may shew us, how dangerous a fracture of the bones of the nose may be, when made by a force applied to the middle fore part, of a person in whom this nasal plate is perpendicular.

The *ethmoid* bone of ripe children is divided into two, by a perpendicular cartilage, which when ossified, is the *crista galli*, and the nasal plate: but its other parts are ossified and complete.

*OS SPHENOIDES* \*, or wedge-shaped bone, so called because of its situation in the

\* Cuneiforme, *πολυμορφον*, multiforme, *paxillum*, *crista palati*, *colatorii*, *cavilla*, *basilare*.

dle of the bones of the *cranium* and face, of such an irregular, figure, that I know not thing to which it may be likened, unless, perhaps, it bear some faint resemblance to a with its wings extended.

When we view the external surface of the *sphenoides*, two or three remarkable processes from each side of it may be observed, each are all of them again subdivided.—The pair is the two large lateral processes or wings; the upper part of each of which is called the *temporal process*, because they join to the temporal bones in forming the temples, and the seat for some share of the *temporal* muscles. That part of the wings which juts out towards the inside, somewhat shorter than the temporal *apophyses*, and is smooth and hollowed, where it makes up part of the orbit, is thence named *orbital processes*. Between the edge, separating these two processes, there is often a small groove, made by a branch of the superior maxillary nerve, in its passage to the temporal muscle. The lowest and back part of each wing, which runs out sharp to the *os petrosa*, has been styled the *sphenoid process*: From near the point of which a sharp pointed process is frequently produced backwards, which some call *styliform*, that affords origin to the *ptery-staphylinus externus* muscle. From this styloid process a very deep groove is extended along the edge of the bone to the hollow at the root of the internal plate of the following processes, which

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forms

forms part of the *Eustachian* tube (a).—The second pair of external processes of the *concha* bone is the two which stand out most perpendicular to the base of the *concha*. Each of them has two plates, and a middle *fossa* facing backwards, and should, to carry our comparison, be likened to the bar's leg, but are commonly said to resemble the wings of that creature; and therefore are named *pterygoid* or *aliform* \* processes. The external plates are broadest, and the internal are longer. From each side of the external plates the *pterygoid* muscles take their rise. At the root of each internal plate, a small hollow may be marked, where the *musculus ptery-staphylin-ternus*, or *circumflexus palati* rises, and its share of the cartilaginous end of the *Eustachian* tube rests; and, at the lower end of the same plate, is a hook-like rising or process round which the tendon of the last named muscle plays, as on a pulley. From the sides of the external plates some small sharp spines stand out; but their number and bulk are uncertain.—To these another pair may be added, to wit, the little triangular thin process which comes from each side of the body of the *sphenoid* bone, where the *pterygoid* processes rise from it, and are extended over the lower part of the aperture of the *sinus* as far as to join the *ethmoid* bone, while their base

(a) Winslow, Exposition anatomique du corps humain, des os secs, § 233.

\* Naviculares.

s down into the *nares* (a). — Besides these of processes, there is a sharp ridge which s out from the middle of its base : Because ants a fellow, it may be called *processus* s. The lower part of this process, where received into the *vomer*, is thick, and often quite perpendicular, but inclining more to side than the other. The fore-part of process. where it joins the nasal plate of s *ethmoides*, is thin and streight. These parts have been described as two distinct sses by some.

ne depressions, sinuosities, and *fossæ*, on external surface of this *sphenoid* bone, may reckoned up to a great number, *viz.* two e temporal *apophyses* where the *crotophite* les lodge. — Two on the *orbital* processes, ke way for the globes of the eyes. — between the *temporal* and *spinous* processes, eceiving the temporal bones. — Two be- n the plates of the *pterygoid* processes, where *musculi pterygoidei interni* and *pterystaphy- interni* are placed. — Two between *pterygoid* and *orbital* processes, for forming oles common to this and to the *cheek* and *lary* bones. Two on the lower ends of *iform* processes, which the *palate* bones into. — Two at the roots of the *tem-* and *pterygoid* processes, where the largest of the external *pterygoid* muscles have rise. — Two at the sides of the *pro-* *azygos*, for forming part of the nose, &c. hat I described under the name of *tempo-*

K 2

ra!

Albin. Tab. oss. 5. fig. 2. 6. A A. — Bertin. Mem. de  
des sciences 1744. — Sur. planche viii. fig. 2. 3. 4. 5. 6.



*ral* and *spinous processes* on the out side of the skull, are likewise seen on its inside, where they are concave, for receiving part of the brain; and commonly three *apophyses* on the internal surface of the *sphenoid* bone are only mentioned.—Two rising broad from the fore-part of its body, become smaller as they are extended obliquely backwards.—The third standing on a long transverse base, near the back-part of the body of this bone, rises nearly erect, and of an equal breadth, terminating often in a little knob on each side. The three are called *clinoid*; from some resemblance which they were thought to have to the supporters of a bed. Sometimes one or both the anterior *clinoid* processes are joined to the sides of the posterior one, or the body of the bone itself.—From the roots of the anterior *clinoid* processes the bone is extended on each side outward and forwards, till it ends in a sharp point which may have the name of the *transverse spinous processes*.—Between, but a little farther back than the two anterior *clinoid* processes, we see a protuberance considerably smaller than the posterior *clinoid* process, but of its shape.—Another process from between the transverse processes, often forces itself forwards into the *os ethmoides*.

Within the skull, there are two sinuosities in the internal part of each wing of the *sphenoid* bone, for receiving the middle part of the brain.—One between the transverse spinous processes, for lodging the part of the brain where the *crura medullæ oblongatæ* are.—Immediately before the third or middle *clinoid* process

process, a single pit generally may be remarked, from which a *fossa* goes out on each side of the holes through which the optic nerves pass. The pit is formed by the conjoined optic nerves; and in the *fossa* these nerves are lodged, as they run divided within the scull. — Between that third protuberance and the posterior *clinoid* process, the larger pit for the *glandula pituitaria* may be remarked. This cavity, because of its resemblance to a *Turkish* saddle, is always described under the name of *sella Turcica*, or *ephippium*. — On the sides of the posterior *clinoid* process a *fossa* may be remarked, that stretches upwards, then is continued forwards along the sides of the *sella Turcica*, near to the anterior *clinoid* processes, where a hole on each side is made. These *fossae* point out the course of the two internal *carotid* arteries, after they have entered the scull. — Besides all these, several other *fossae* may be observed, leading to the several holes, and imbricated by the nerves and blood-vessels.

The holes on each side of the *os sphenoides* are six proper, and three common. — The first is the round one immediately below the anterior *clinoid* processes, for the passage of the optic nerve, and of the branch of the internal *carotid* artery that is sent to the eye. —

The second is the *foramen lacerum*, or large hole between the transverse spinous and orbital processes: The interior end of which slit is large; and, as it is extended outwards, it becomes narrower. The outer end of it is formed in the *os frontis*; and therefore this might be reckoned among the common *foramina*.

Through it the third, fourth, the first branch of the fifth, and the greater share of the sixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a small branch of the external carotid enters near its end, to be distributed to the *dura mater* (a) and a vein, some call it the *venous duct*, or *Nuck's aqueduct*, returns through it to the cavernous sinus. — The *third* hole, situated a little below the one just now described, is called *rotundum*, from its shape. It allows passage to the second branch of the fifth pair of nerves or superior maxillary nerve, into the bottom of the orbit. — The *fourth* is the *foramen ovale*, about half an inch behind the round hole. Through it the third branch of the fifth pair, inferior maxillary nerve, goes out; and sometimes a vein from the *dura mater* passes here (b). — Very near the point of the spinous process is the *fifth* hole of this bone: it is small and round, for a passage to the large artery of the *dura mater*, which often is accompanied with a vein. — The *sixth* process hole (c) cannot be well seen, till the cuneiform bone is separated from all the other bones of the *cranium*; for one end of it is hid by a small protuberance of the internal plate of the petrous process, and by the point of the process

(a) Winslow, Exposition anatomique du corps humain, des arteries, § 60. et de la tête, § 26.

(b) Ingrass. Commentar. in Galen. de ossib. lib. 1. cap. 8.

(c) Vesal. Anat. lib. 1. cap. 12. — Eustach. tab. fig. 13. & 16. — Vidus Vidius, Anat. lib. 2. cap. 2. cap. tab. 5. & tab. 5 fig. 8, 9, 10. lit. O.

process of the *temporal* bone. Its canal is extended above the inner plate of the *pterygoid* process; and where it opens into the cavity of the nose, it is concealed by the thin laminous part of the *palate* bone. Through it a considerable branch of the second branch of the *fifth* pair of nerves is reflected. — Often in the middle of the *sella Turcica* a small hole or two, or as far as the cellular substance of the bone; and sometimes at the sides of this *sella*, one or more small holes penetrate into the *sinusoid* sinuses. These observations afford some anatomists (a) an argument of weight in their days in defence of *Galen* (b), who asserted the descent of the *pituita* that way into the sinuses below.

The first of the common holes is that unequal one at the side of the *sella Turcica*, between the extreme point of the *os petrosum* and the *transverse* process of the cuneiform bone. This hole only appears after the bones are boiled; in a recent subject its back-part is covered by a thin bony plate that lies over the internal carotid artery, and further forward it is filled with a cartilaginous ligament, under which the cartilaginous part of the *Eustachian tube* is placed: It was by this passage that the ancients believed the *slimy matter* was conveyed from the excretory of the brain, the *glandula pituitaria*, to the *fauces*. — The second common one is the large discontinuation of the external side of the orbit, left between the orbital processes

(a) Jac. Sylv. *Calumniæ secundæ amolitio*. — Laurent. Hist. lib. 2. quæst. 11.

(b) Galen. *De usu part.* lib. 9. cap. 1.



processes of the cuneiform bone, the *os maxillare, male, and palati*. In this large hole the fat for lubricating the globe of the eye and temporal muscle is lodged, and branches of the superior maxillary nerve, with small arteries from the carotid and veins pass. — The third hole is formed between the base of this bone and the root of the orbital process of the palate-bone of each side. Through this a branch of the external carotid artery, and of the second branch of the fifth pair of nerves, are allowed a passage to the nostrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate bone, being entirely formed out of its substance.

Under the *sella Turcica*, and some way farther forward, but within the substance of the *sphenoid* bone, are two *sinuses*, separated by bony plate. Each of them is lined with membrane, and opens into the upper and back part of each nostril by a round hole, which is at their upper fore-part. This hole is formed only by the *os sphenoides*, which has an aperture near as large as any transverse section of the *sinus*, but also by the *palatine* bones which are applied to the fore part of these *sinuses*, and close them up, that hole only excepted, which was already mentioned. Frequently the two *sinuses* are of unequal dimensions, and sometimes there is only one large cavity, with an opening into one nostril. These cavities are likewise said (a) to be extended sometimes as far back as the *foramen* of the occipital bone. In other

(a) Albin. de offib. § 39.

ts they are not to be found, when the bone is composed of large cells (*a*). Some (*b*) mention a cavity within the partition of the *sinuses*; it is small. — The *sphenoidal sinuses* serve the same uses as the frontal do.

As this bone is extremely ragged and unequal, so its substance is of very different thickness, being in some places diaphanous; in others it is of a middle thickness, and its middle back part surpasses the greatest share of the *anium* in thickness.

The *os sphenoides* is joined, by its wings, to the *parietal* bones above, to the *os frontis ossa malarum* before, to the *temporal* bones behind; — By the fore-part of its body and various processes, to the *frontal* and *ethmoidal* bones; — by its back part, behind the two *sinuses* to the *occipital*, where it looks like a bone in the *epiphyses* taken off, and, as was formerly observed in the description of the *occipital* bone, it cannot be separated without violence in adults; — to the *palate* bones, by the ends of the *pterygoid* processes, and still more by the fore-part of the internal plates of the *pterygoid* processes, and of the *sinuses*; — to the *maxillary* bones, by the fore-part of the internal *pterygoid* plates; — to the *vomer* and the plate of the *os ethmoides*, by the *processus azygos*. All these conjunctions, except the last, which is a *schindylesis*, are said to be the suture proper to this bone; though it is almost sight evident, that several other sutures,

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Vesal. lib. 1. cap. 6.

Id. ibid.

as the *transverse, ethmoidal, &c.* are confounded with it.

We see now how this bone is joined to all the bones of the *cranium*, and to most of the upper jaw; and therefore obtained the name of the *wedge like bone*.

The uses are so blended with the description as to leave nothing new to be added concerning them.

The *sphenoidal* bone is almost compleat in *fetus* of nine months; only the great *ala* separate after maceration from the body of the bone.—The *processus azygos* is very large and hollow;—the thin triangular processes are ossified—the internal surface of the body unequal and porous;—the *sinuses* do not appear.

Whoever is acquainted with each bone of the *cranium*, can, without difficulty, examine them as they stand united, so as to know the shapes, sizes, distances, &c. of their several parts, and the forms, capacities, &c. of the cavities formed by them, which is of great use towards understanding the anatomy of the parts contiguous to, contained within, or connected with them. Such a review is necessary, after considering each class of bones. Thus the orbits, nostrils, mouth, face, head, spine, *thorax*, pelvis, trunk, extremities, and skeleton, ought likewise to be examined.

The *FACE* is the irregular pile of bones composing the fore and under part of the head, which is divided, by authors, into the upper and lower *maxille* or jaws.

The *superior maxilla* \* is the common designation given to the upper immoveable share of the face ; though, if we would follow *Celsus* (a), we should apply the word *maxilla* to the lower jaw only, and the name *mala* to this upper jaw. In complaisance to prevailing custom, I shall, however, use the terms now commonly employed. The shape of the superior jaw cannot easily be expressed ; it is necessary, provided the shape and situation of all the bones which compose it are described. It is bounded above by the transverse sphenoid bone, behind by the fore-part of the *sphenoid* bone, and below by the mouth.

The upper jaw consists of six bones on each side, of a thirteenth bone which has no fellow, placed in the middle, and of sixteen in all. The thirteen bones are, two *ossa nasi*, two *ossa unguis*, two *ossa malarum*, two *ossa maxillaria*, two *ossa palati*, two *ossa spongiosa*, and the *vomer*.

The *ossa nasi* are placed at the upper part of the nose ;—the *ossa unguis* are at the internal *canthi* of the orbits ;—*ossa malarum* form the prominence of the cheeks ;—*ossa maxillaria* form the side of the nose, with the whole lower and fore part of the upper jaw, and the greatest share of the roof of the mouth ;—*ossa palati* are situated at the back of the palate, nostrils, and orbit ;—*ossa spongiosa* are seen in the lower part of the nasal cavity—and the *vomer* helps to separate these two cavities.

The

*ἑταῖον, γένος, mandibula.*

Lib. 8. cap. 1.



The bones of the *upper jaw* are joined to the bones of the skull by the *schindylesis* and sutures already described as common to the *cranium* and *face*, and they are connected to each other by *gomphosis* and fifteen sutures.

The *gomphosis* only is where the teeth are fixed in their sockets, and the *schindylesis* only where the edges of the *vomer* are joined to other bones.

The sutures are generally distinguished by numbers, which have been differently applied; and therefore I join those (a) who prefer giving names to each, which may be easily contrived from their situation, or from the bones which they connect.

The first is the *anterior nasal* \*, which is straight, and placed longitudinally in the middle fore-part of the nose.

The second and third are the *lateral nasal*, which are at each side of the nose, and are parallel to the first suture.

Each of the two *lacrymal* is almost semicircular, and is placed round the *lacrymal groove*.

The sixth and seventh are the *internal orbital*: each of which is extended obliquely from the middle of the lower side of an orbit to the edge of its base.

The two *external orbitals* are continued from the end of the internal orbital, to the under and fore-part of the cheek.

(a) Vander Linden. *Medicin. physiolog.* cap. 13. art. 1.  
—Rolfinc. *Anat. lib. 2. cap. 25.*—Schenk. *Schol. part.*  
par. 2. cap. 5.

\* *Nasalis recta.*

† *Nasalis obliqua.*

The tenth is the *mylarchial*, which reaches  
ly from the lower part of the *septum narium*  
between the two middle *dentes incisores*.

The *longitudinal palate* \* suture stretches  
from the middle of the foremost teeth through  
the middle of all the palate.

The *transverse palate* one † runs across the  
palate, nearer the back than the fore-part of

Each of the two *palato-maxillary* is at the  
back-part of the side of each nostril.

The fifteenth is the *spinous*, which is in the  
middle of the lower part of the nostrils. This  
may perhaps be rather thought a double *schin-*  
*sis*.

The connection of the *ossa spongiosa* to the  
side of each nostril, is so much by a mem-  
brane in young subjects, by a sort of hook and  
eye, afterwards by concretion or union of substance  
in adults, that I did not know well how to  
describe it: But if any chuses to call it a suture,  
the addition of two *transverse nasal* sutures  
may be made to those above named.

These sutures of the face (formerly called  
*monia*) have not such conspicuous indenta-  
tions as those of the skull have; the bones  
not having substance enough for forming  
such indentations, and there being less neces-  
sity for security against external injuries, or  
internal protruding force, than in the cra-  
nium. — These sutures often disappear in old  
people, by the bones running into each other;  
which can do little prejudice, because the prin-

L

cipal

*Laquearis, palataria recta.*

*Arcuata, palatina postica.*

incipal use of the bones being so numerous here, is to allow them to be extended into a proper form.

It is evident, from the manner of the conjunction of these bones, that they can have no motion, except in common with the *cranium*.

The purposes which this pile of bones serves will be shewn in the description which I am to give of each of them.

*OSSA NASI*, so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broader at their lower end, narrowest a little higher than their middle, and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, towards their connection with the *frontal* bone might be stronger.—These bones are convex externally, and thereby better resist any violence from without; and they are concave internally for enlarging the cavity of the nose.

The lower edge of these bones is unequal and is stretched outwards and backwards, to join the cartilages of the nostrils.—Their anterior side is thick, especially above, and unequal, so that their conjunction to each other might be stronger; and a small rising may be remarked on their inner edge, where they are sustained by the *septum narium*.—Their posterior surface at its upper half, has externally a depression where it is overlopped some way by the *maxillary* bones, while its lower half covers the *maxillary* bones: By which contrivance, they do not yield easily to pressure applied to their fore- or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four holes, which appear internally, terminate for the transmission of small veins; sometimes the holes go no further than the *cancelli* of the bones.

The *nasal bones* are firm and solid, with very few *cells* or *cancelli* in them: the thin substance of which they consist not requiring much marrow.

They are joined above to the *frontal bone*, in the middle of the *transverse suture*: — behind, to the *maxillary bones*, by the *lateral nasal sutures*; — Below, to the cartilages of the nose; — Before, to one another, by the *anterior nasal suture*; — internally, to the *septum nasale*.

These bones serve to cover and defend the tip of the nose.

In an infant the *nasal bones* are proportionally shorter, and less thick at their upper part, than in an adult, but are otherwise complete.

*OS SAUINGUIS*, or *LACRIMALIA*, so named, because their figure and magnitude are something near to those of a nail of the finger, and because the tears pass upon them into the nose.

Their external surface is composed of two deep concavities and a middle ridge. — The depression behind forms a small share of the orbit for the eye-ball to move on, and the depression before is a deep perpendicular canal, or groove, larger above than below, containing part of the *lacrymal sac* and *duct*. This is the part which is thought to be pierced in the great operation.



tion for the *fistula lacrymalis*.—This *fossa* of the bone is cribriform, or has a great number of small holes through it, that the filaments from the membrane which lines it, insinuating themselves into these holes, might prevent separation of the membrane, and secure the bone in its natural situation.—The ridge between these two cavities of the *os unguis*, is the proper boundary of the orbit at its internal *canthus*; and beyond which surgeons should not proceed backwards in performing operations here.—The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the *os unguis* is as thin as paper, and very brittle; which is the reason that those bones are often wanting in skeletons, and need little force to pierce them in living subjects.

Each of these bones is joined, above, to the *frontal* bone, by part of the *transverse* suture.—behind, to the *os planum* of the *ethmoid* bone, by the same suture;—before, and below, to the *maxillary* bone, by the *lacrymal* suture.—internally, the *ossa unguis* cover some of the *sinus ethmoidales*; nay, are really continued with the bony *lamellæ* which make up the sides of these cells; so that they are as much part of the *ethmoid* bone as the *ossa plana*.

These unguiform bones compose the anterior internal parts of the orbits, lodge a share of the lacrymal sac and duct, and cover the *ethmoid* cells.—Their situation and tender substance make a rash operator in danger of destroying a considerable share of the organ of smell.

elling, when he is performing the operation the *fistula lacrymalis*; but when these bones are hurt, they cast off without much difficulty, and consequently the wound is soon healed, unless the patient labours under a general *cacoethes*, or there is a predisposition in the bones to *caries*; in which case, a large train of bad symptoms follow, or, at best, the cure proves tedious.

These bones are fully formed in a new born child.

*OSSA MALARUM* \* was the name given by Celsus, as was already remarked, to all the bones of the jaw; but is now appropriated to the prominent square bones which form the cheek on each side. — Before, their surface is convex and smooth; backward, it is unequal and concave, for lodging part of the *crotaphyte* muscles.

The four angles of each of these bones have been reckoned processes by some. — The one at the external *canthus* of the orbit, called the *anterior orbital* process, is the longest and thickest. — The second terminates near the middle of the lower edge of the orbit in a sharp point, and is named the *inferior orbital* process. — The third, placed near the lower part of the cheek, and thence called *maxillary*, is the strongest, and nearest to a right angle. — The fourth, which is called *zygomatic*, because it is extended backwards to the *zygoma* of the temporal bone, ends in a point, and has one side straight, and the other sloping. — Between the

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Jugalia vel zygomatica, hypopia, subocularia.

two orbital angles there is a concave arch which makes about a third of the external circumference of the orbit, from which a fifth process is extended backwards within the orbit, to form near one third of that cavity; and hence it may be called the *internal orbital process*. From the lower edge of each of the *ossa malarum*, which is between the maxillary and zygomatic processes, the *masseter* muscle takes its origin; and from the exterior part of the zygomatic process, the *musculus distortor oris* rises; in both of which places the surface of the bone is rough.

On the external surface of each cheek-bone one or more small holes are commonly found for the transmission of small nerves or blood vessels from, and sometimes into the orbit.

On the internal surface are the holes for the passage of the nutritious vessels of these bones.

—A notch on the outside of the *internal orbital process* of each of these bones assists to form the great slit common to this bone and to the sphenoid, maxillary, and palate bones.

The substance of these bones is, in proportion to their bulk, thick, hard, and solid, with some *cancelli*.

Each of the *ossa malarum* is joined, by the superior and internal orbital processes, to the *os frontis*, and to the orbital process of the *sphenoid* bone, by the *transverse suture*.—The edge between the internal and inferior orbital processes, to the *maxillary* bone, by the *internal orbital suture*.—By the side between the maxillary and inferior orbital process, and to the maxillary bone, by the *external orbital suture*.

ture.—By the zygomatic process, to the *os zygomaticum*, by the zygomatic suture.

The cheek-bones are entire, and fully ossified in all their parts in infants.

*OSSA MAXILLARIA SUPERIORA*, the largest bones, and constitute the greater part of the upper jaw, which has appropriated the name of *maxillaria* to them. The figure of one of them, or of the two when joined, is so irregular, that words can scarce give an idea of it.

The processes of each *os maxillare* may be reckoned seven.—The *first* is the long nasal process at its upper and fore-part, which is broad below, and turns smaller, as it rises upwards, to make the side of the nose.—At the root of this, a transverse ridge may be observed within the nostrils, which supports the fore-part of the upper edge of the *os spongiosum inferius*.—The *second* is produced backwards and outwards, from the root of the nasal process, to form the lower side of the orbit; and therefore may be called *orbital*.—The edge of this orbital process, and the ridge of the nasal one, which is continued from it, make a considerable portion of the external circumference of the orbit.—From the proper orbital process, a very rough angular surface is extended downwards and backwards, to be connected to the cheek-bone; and therefore may be called the *malar* process, from the lowest protuberant part of which the share of the masseter muscle takes its rise.—Behind the orbital process, a large tuberosity or bulge of the bone appears, which is esteemed the *fourth* process.—On the internal part



part of this we often meet with a ridge, almost of the same height with that in the nasal process, which runs transversely, and is covered by a similar ridge of the *palate* bone, on which the back part of the upper edge of the *os spongiosum inferius* rests.—The convex back-part of this tuberosity is rough for the origin of part of the external *pterygoid* muscle (a), and more internally is scabrous, where the *palate* and *sphenoid* bones are joined to it.—That spongy protuberance \* at the lower circumference of this bone, where the sockets for the teeth are formed, is reckoned the *ffib*.—The *sixth* is the horizontal plate, which forms the greater part of the base of the nostrils; and roof of the mouth; its upper surface, which belongs to the nostrils, is very smooth, but the other below is arched and rough, for the stronger adhesion of the membrane of the mouth which is stretched upon it, and in chewing, speaking, &c. might otherwise be liable to be separated.—The *seventh* rises like a spine from the inner edge of the last, and forms a small part of the partition of the nostrils.

The depressions in each *maxillary* bone are  
 1. A sinuosity behind the orbital process, made by the *temporal* muscle. 2. A pit immediately before the same process, where the origin of the *musculus elevator labiorum communis*, and *elevator labii superioris*, with a branch of the fifth pair of nerves, are lodged securely. 3. The hollow arch of the *palate*. 4. The semicircular great notch, or entry to the lower part

(a) Albin. de ossib. § 79.

• πατυία.

the nostrils, betwixt the root of the nasal process and spine of the palate-plate.—Below this, the fore-part of the bone is flattened, sometimes hollowed by the *musculus depressor labii superioris*. 5. Sockets for the teeth †: the number of these sockets is uncertain; for the same number of teeth is not in all people, and the four backmost teeth of each side of each jaw vary greatly in their number of sockets; and when the teeth of a living person fall out, or are taken away, the sockets fill up with an osseous net-work, which becomes solid afterwards.—6. The *lacrymal fossa* in the *nasal process*, which assists the *os unguis* to form a passage for the *lacrymal duct*. This part of the bone forming this *fossa* is so firm and strong that a surgeon scarce can perforate it with the ordinary instruments for the *fistula lacrymalis*, and therefore ought to avoid it in doing this operation.—Immediately on the outside of this, there is a small depression, from which the inferior or external oblique muscle of the eye has its origin (a). The canal on the upper part of the great tuberosity within the orbit, which is almost a complete hole; in this a branch of the superior maxillary nerve passes.—Besides these, the superior surface of the great bulge is concave, to receive the under part of the eye.—Immediately above the transverse ridge in the nasal process, a small hollow is formed by the *os spongiosum*.—In some subjects, the nasal process has a small round pit above the lacrymal duct, where

Βόβρις, ὀλμίσκος, alveoli, fossulae, mortariola, fræna,   
 πάλσις, pralsepiola, loculamenta.

Winslow, Exposition anatomique des os secs, § 276.

where the little tendon or ligament of the orbicular muscle of the eye-lids is inserted. It is this tendon, and not the tendon of the larger oblique muscle of the eye, which there is some hazard of cutting in the operation of the *fistula lacrymalis*.

The holes of this bone are two proper and two common, which are always to be found besides several others, whose magnitude, number, &c. are uncertain.——The first of the proper is the *external orbital*, immediately below the orbit, by which the infra-orbital branch of the second branch of the fifth pair of nerves, and a small artery, come out, after having passed in the canal, at the bottom of the orbit, described *numb. 7.* of the depressions.—This hole is often double, and this when the nerve has happened to split before it has escaped from the bone —The second is the *foramen incisivum*, just behind the fore-teeth, which, at its under part, is one irregular hole common to both the *maxillary* bones when they are joined; but, as it ascends, soon divides into two, three, or sometimes more holes, some of which open into each nostril. Through them small arteries and veins, and a twig of the second branch of the fifth pair of nerves pass, and make a communication between, and join the lining coats of the nose and mouth. In some subjects, *Steno's duct* may be traced some way on the side of these passages next to the nose, and small orifices may be observed opening into the mouth.

The first common hole is that which appears at the inner side of the back-part of the

ty and of the sockets of the teeth, and is formed by a *fossa* in this bone, and a corresponding one in the *os palati*: through it a vein, which is a branch of the second branch of the fifth pair, runs to the palate.——The other common hole is the great slit in the outer wall of the orbit described already, as the second common hole of the sphenoid bone.

On the nasal process often holes may be observed for the passage of vessels to the substance of the bones; and, at the back part of the tuberosity, several *foramina* are placed, for the transmission of nerves to the cavity of the sinus: but these are uncertain.

All the body of the *maxillary* bone is hollow, and leaves a large *sinus* akin to the *frontal* and *sphenoid*, which is commonly, but unjustly, called *antrum Highmurianum* \*. When the *os maxillare* is single or separated from all the other bones of a skeleton, its *antrum* appears to be a large aperture into the nostrils; but, in the present subject, it is so covered at its back by the *palate* bone; in the middle, by the *spongiosum inferius*; before, by a strong membrane, that one or sometimes two holes, the larger than a crow-quill, are only left at the upper part; which, after a short winding passage, open into the nostrils between the *ossa spongiosa*.—At the bottom of this cavity we may often observe some protuberances, which the small points of the roots of the teeth are contained (*a*).—This cavern and the sockets of the teeth are often divided by the

Genæ.

Highmore, Disquis. anat. lib. 3. part. 2. cap. 1.



the interposition only of a very thin bony plate which is liable to be eroded by acrid matter collected in the *antrum*, or to be broke in drawing a tooth (a). The symptoms of a collection of a matter here naturally lead us to the practice of pulling out the teeth, and piercing through this plate into the *antrum*, to procure an evacuation of the collected matter; which considerable service is frequently done.

The *maxillary sinuses* have the same uses as the *frontal* and *sphenoidal*; and the situation of the *sinuses* is such, that the liquor drilled from them, from the cells of the ethmoid and palate bones, and from the lacrymal ducts, may always moisten all the parts of the membrane of the *nares* in the different situation which the head is in.

Though the membranes which line the *frontal*, *sphenoidal*, and *maxillary sinuses*, are continuations of the one which covers the bones within the nose; yet they are much thinner than it is, and have so much smaller vessels, that the injection which makes the membrane of the nose red all over, fills only some few vessels of the *maxillary sinuses*, and scarce is observed in the *frontal* and *sphenoidal*. Are not the larger vessels intended for a plentiful secretion of a viscid liquor to defend the membrane from the effects of the *perforatus*, which is constantly through the nose? Are not the membranes which have the smaller vessels, *ceteris paribus*, the most sensible?

(a) Highmore, *ibid.*

(b) Cowper in Drake's *anthropol.* book 3. chap. 10.  
Medical Essays and observ. vol. 5. art. 30.

at many phænomena of smelling, inflammations of these parts, *megrin*, *polypi*, &c. depending on this structure of these membranes? The substance of the *ossa maxillaria* is compact and firm, except at the inferior processes, which the teeth are lodged, where it is very spongy.

The *maxillary* bones are joined above by the upper ends of their nasal processes to the *os frontis*, by the *transverse* suture;—at the sides of these processes, to the *ossa unguis*, by the *lacrimal* sutures;—to the *nasal* bones, by the *lateral nasal* sutures;—by their orbital processes, to the *cheek* bones, by the *external orbital* sutures;—by the internal sides of the internal orbital processes, to the *ossa plana*, by part of the *ethmoidal* suture;—by the back-part of the *tuberosities*, to the *palate* bones, by the *os palato-maxillares*;—by the posterior ends of their palatine *lamellæ*, to the *os palati*, by the *transverse* palate suture;—by their nasal *spines*, to the *vomer*, by the *spinous* suture;—by their sockets, to the teeth by the *gomphosis*;—by the internal edge of the *palate-plate*, to one another, by the *longitudinal* palate-suture; on the upper and fore-part of which a furrow is left for receiving the *perilagus* which forms the partition of the nostrils;—between the fore part of the nostrils and the mouth, to each other, by the *mustachial* suture;—sometimes they are connected to the *spongia inferiora*, by a plain concretion or *osseous* substance.

These bones form the greater part of the sides and of the roof of the mouth, and a

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considerable share of the orbit. They contain sixteen teeth, give rise to muscles, transmission to nerves, &c. as mentioned in the description of their several parts.

In each of the *maxillary* bones of a newborn child, the external orbital process is low with remarkable holes in it;—there are five sockets for the teeth, of which the two posterior are very large, and, when divided by a second cross partition, make the number of sockets six (*a*).—The palate-plate is cribrate form about the middle.—The great tuberosity is not formed;—instead of the *antrum* there is only an oblong depression at the side of the nostrils.

*OSSA PALATI* are commonly described as two small square bones, at the back-part of the palate or roof of the mouth, though they are of much greater extent, being continued to the back-part of the nostrils to the orbit. Each palate-bone may therefore be divided into four parts, the palate square bone, the pygoid process, nasal *lamella*, and orbital process.

The square bone is unequally concave, enlarging both the mouth and cavity of the nose. The upper part of its internal surface rises in a spine, after the same manner as the palate-plate of the *maxillary* bone does, to be joined with the *vomer*.—Its anterior surface is unequally ragged, for its firmer connection

(*a*) Albin. Osteogen. tab. 5. fig. 45.—Ungeheuer. dentit. secund. juv. § 1.

(*b*) Eustach. tab. 47. fig. 1. 3. 6. 7. 8.—Vidius, de Anat. lib. 2. cap. 2. explicat. tab. 6. fig. 19.—Flow. Mémoires de l'acad. des sciences, 1720.

the palate-process of the *os maxillare*.—The internal edge is thicker than the rest, and has an equal surface, for its conjunction with the fellow of the other side.——Behind, this bone is somewhat in form of a crescent, and thick, for the firm connection of the *velum palati*; the internal point being produced backwards, to afford origin to the *palato-staphylinus* or *azygos* muscle.——This square bone is distinguished from the *pterygoid* process by a perpendicular *fossa*, which, applied to such a hole in the *maxillary* bone, forms a passage for the palatine branch of the fifth pair of nerves; and by another small hole behind this, through which a twig of the same nerve passes. The *pterygoid* process is somewhat triangular, having a broad base, and ending smaller above. The back-part of this process has three *fossae* defined in it; the two lateral receive the ends of the two plates of the sphenoid bone, that are commonly compared to a bat's wing; the middle *fossa* makes up a part of what it commonly called the *fossa pterygoidea*; the fore side of the palatine pterygoid process is an irregular surface, where it receives the back part of the *tuberosity* of the *maxillary* bone.——Frequently several small holes may be observed in the triangular process, particularly one near the middle of its base, which a little above communicates with the common and proper sinus of this bone already taken notice of. The *nasal lamella* of this bone is extremely thin and brittle, and rises upwards from the upper side of the external edge of the square-process, and from the narrow extremity of the



*pterygoid* process; where it is so weak, and, at the same time, so firmly fixed to the *maxillary* bone, as to be very liable to be broken in separating the bones.——From the part where the plate rises, it runs up broad on the inside of the *tuberosity* of the *maxillary* bone, to form a considerable share of the sides of the *maxillary sinus*, and to close up the space between the *sphenoid* and the great bulge of the *maxillary* bone, where there would otherwise be a large slit opening into the nostrils. From the middle internal side of this plate, a cross ridge placed on such another of the *maxillary* bone is extended; on it, the back part of the *os spongiosum inferius* rests. Along the outside of this plate, the perpendicular *fossa* made by the palate nerve is observable.

At the upper part of this nasal plate, the palate bone divides into two processes, which I already named *orbital*;—between which and the body of the *sphenoid* bone, that hole is formed, which I mentioned as the last of the holes common to the *sphenoid* bone.——Sometimes this hole is wholly formed in the *os palati*, by a cross plate going from the one *orbital* process to the other. A nerve, artery, and vein belonging to the nostrils pass here.—The anterior of the two *orbital* processes is the largest, and has its fore-part contiguous to the back-part of the *maxillary sinus*, and its upper surface appears in the bottom of the orbit, behind the back-part of the *os maxillare* and

n.—It has cells behind resembling those of the *ethmoid* bone, to which it is contiguous ; it is placed on the aperture of the *sinus sphenoidalis*, so as to leave only a round hole at its upper fore-part.—The other part of the orbital process is extended along the internal side of the upper back part of the maxillary *tuberosity*, to the base of the *sphenoid* bone, between the process of the *processus azygos* and the pterygoid process.

The palate square part of this palate-bone, and its pterygoid process, are firm and strong, with some *cancelli* ; but the nasal plate and orbital processes are very thin and brittle.

The palate-bones are joined to the *maxilla* by the fore-edge of the palate square bone, to the *transverse palate* suture :—By their thin nasal plates, and part of their orbital processes, to the same bones, by the *palato-maxillares* sutures :—By their *pterygoid* processes, and back-edges of the *nasal plates*, to the *ala vespertilionis*, by the *sphenoid* suture :—By the transverse ridges of the nasal plates, to the *ossa alveolaria inferiora*, by contact ; hence frequently there is an intimate union of the substance of these bones in old skulls :—By the orbital processes, to the *ossa plana* and *cellula ethmoidalis*, by the *ethmoid* suture :—To the body of the *sphenoid* bone, by the *sphenoid* suture :—To the internal edge of the square bones, to the other, by the *longitudinal palate* suture ; and by their nasal spines, to the *vomer*, by the *nasal* suture.

The palate-bones form part of the palate, orbits, and *fossæ pterygoideæ*, and

they cover part of the *sinus maxillares*, *sphenoidales*, and *ethmoides*.

These bones are very complete in a new-born infant, the nasal plates being then thicker and stronger than in adults; but the orbital processes have not the cells which appear in the bones of adults.

When we are acquainted with the history of these bones, the reason is evident, why the eyes are so much affected in ulcers of the palate, as to be often attended with blindness, which frequently happens in an ill-managed *lues venerea*; or why, on the other hand, the palate suffers from an *aglyops* (a).

*OSSA TURBINATA*, or *spongiosa inferiora*, resemble the superior *ossa spongiosa* in shape and substance, but have their anterior and upper edges contiguous to the transverse ridge of the nasal processes of the *maxillary* and *palate bones*.—From their upper straight edge two small processes stand out: the posterior which is the broadest, descends to cover some of the *antrum Highmorianum*; the anterior rises up to join the *os unguis*, and to make part of the *lacrymal duct*.

Below the spongy bones already mentioned there are sometimes two others, one in each nostril, which seem to be a production of the sides of the maxillary *sinus* turned downwards (b). When this third sort of spongy bones is found, the middle one of the three in each nostril is the largest, and the lowest is the smallest.

(a) Hoffman. in Ephemerid. German. cent. 1. and 2. serv. 135.

(b) Cowper in Drake's Anthropol. book 3. chap. 10.

—Besides all these, there are often several other small bones standing out into the nostrils, that, from their shape, might also deserve the name of *turbinata*, but are uncertain in their place, situation, and number (a).

The names of these bones sufficiently declare their spongy substance, which has no firm external plate covering it.

They are joined to the *ossa maxillaria*, palate, and *unguis* in old subjects, by a firm union of substance; and as this happens also frequently in people of no great age, some (b) are of opinion, that they should be esteemed part of the palate-bones; others (c) think, that since their upper edge is continued by a plate to a part of the *os ethmoides*, they ought to be esteemed to be a part of this bone.

Their use is, to straiten the nostrils, to afford a large surface for extending the organ of smelling, to cover part of the *antra maxillaria*, and to assist in forming the under part of the lacrymal ducts, the orifices of which into the nose are concealed by these bones.

The *ossa turbinata* are nearly complete in a newly born infant.

*ALVOLI*, or bone resembling a ploughshare, is the thirteenth of the upper jaw, with a fellow, forming the lower and back parts of the partition of the nose (d).

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(a) Santorin. Observat. anatomic cap. 5. § 9.

(b) Id. ibid. cap. 5. § 7.

(c) Hunauld. in Memoires de l'acad. des sciences, 1730.

(d) Columb. de re anat. lib. 1. cap. 8. — Fallop. Observat.



The figure of this bone is an irregular rhomboid.—Its sides are flat and smooth.—Its posterior edge appears in an oblique direction at the back-part of the nostrils.—The upper one is firmly united to the base of the *sphenoid* bone, and to the nasal plate of the *ethmoid*; and, when it can be got separated, is hollow, for receiving the *processus azygos* of the *sphenoid*.—The anterior edge has a long furrow in it, where the middle cartilage of the nose enters.—The lower edge is firmly united to the nasal spines of the maxillary and palate bones.—These edges of this bone are much thicker than its middle, which is as thin as the finest paper; by which, and the firm union or connection this bone has above and below, it can very seldom be separated entire in adults: But, in a child, it is much more easily separated entire, and its structure is more distinctly seen; wherefore I shall examine its parts of such a subject.

Its situation is not always perpendicular, but is often inclined and bended to one side, as well as the nasal plate of the *ethmoid* bone.

The *vomer* is convex at its upper part, and then is straight, as it is extended downwards and forwards where it is composed of two plates the edges of which have a great number of small processes, disposed somewhat like the teeth of a saw, but more irregularly, and several of them are reflected back. Between these plates a deep *fossa* is left, which, towards the top of the curvature, is wide, and has strong sides, for receiving the *processus azygos* of the *sphenoid* bone. Beyond the arch of the

wards, the *fossa* is narrower and shallower gradually to the point of the bone, receiving for one way the nasal *lamella ethmoidea*; which, after the ossification is complete, is so closely united to the *vomer* by the little processes piercing into its substance, as to prevent any separation; on which account it has been esteemed some (a) a part of the ethmoid bone. The middle cartilage of the nose fills up what remains of the *fossa* at its fore-part.——The anterior edge of the *vomer*, which appears above the back-part of the palate-bones, is broader above; but as it descends forwards, becomes thinner, though it is still solid and firm. The lower edge of this bone, which rests on the nasal spine of the *palate* and *maxillary* bones, has a little furrow on each side of a small middle ridge, answering to the spines of the bones of different sides, and the interspace between them. This edge, and the upper one meet in the pointed fore-end of this bone.

The body of the *vomer* has a smooth surface, and solid, but thin substance; and towards the sides, where it is thickest, some *cancelli* may be observed, when the bone is broken.

It is joined above to the *sphenoid* and *ethmoid* bones, and to the middle cartilage of the nose, by the *schindylesis*;—below, to the maxillary and palate bones, by the *spinous* suture.

The *vomer* divides the nostrils, enlarges the organ of smelling, by allowing place for extending the membrane of the nose on its sides, and sustains the palate-plates of the *maxillary*

(a) Lieutaud. Essais anatomiques 1. sect. l'os ethmoide.

*xillary* and *palate* bones, which otherwise might be in hazard of being pressed into the nostrils; while the *vomer* is secured from shuffling to one side or other by the double *schindylesis*, by which it is joined to the bones above and below.

These then are all the bones which compose the upper jaw, except the teeth, which are so much a-kin to those of the lower jaw, that I chuse to make one description serve for both; in which the differences observable in them shall be remarked, after the second part of the face, the lower jaw, is examined; because the structure of the teeth cannot be well understood, until the case in which they are set is explained.

**MAXILLA INFERIOR** \*, the lower jaw consists only of one moveable bone, and sixteen teeth incased into it.

This bone, which is somewhat of the figure of the *Greek* letter *υ*, is situated at the lower part of the face, so as its convex middle part is forwards, and its legs are stretched back. It is commonly divided into the *chin*, *sides*, and *processes*.—The *chin* is the middle fore part, the extent of which to each side is marked on the external surface by the holes observable there, and internally by the beginning of an oblique ridge.—Beyond these the *sides* appear, and are continued till the bone, by bending upwards, begins to form the *processes*.

On the fore-part of the *chin*, a transverse ridge appears in the middle, on each side of which

\* Τίς, σιαγών, mandibula, facies.

which the *musculi quadrati*, or *depressores labii inferioris*, and the *levator labii inferioris*, depress the bone : And below these prints, a small ridge may be observed, where the *depressores* commence.—On the back-part of the chin, sometimes three, always two, small protuberances appear in the middle. To the uppermost, when it is seen, the *frænum* of the tongue is connected. From the middle one, the *musculi genioglossi* rise ; and from the lowest, the *geniohyoidei* have their origin. Below the last, we see two rough sinuosities formed by the *digastric* muscles.

At the lower and fore-part of the external face of each side of the lower jaw, a small eminence may be observed, where the *depressor labiorum communis* rises. Near the upper edge of the side a ridge runs length-ways, to which the under part of the *musculus buccinator* is connected.—Internally, towards the inner edge of each side, another ridge appears, to which the *mylohyoidei* have their origin, and to which the internal membrane of the jaw adheres.

On the upper edge of both chin and sides there are a great many deep pits or sockets, for receiving the roots of the teeth. The number and magnitude of these sockets are various, because of the different number, as well of the teeth themselves, as of their roots, in different people. These sockets in this lower jaw, as well as in the upper one, are less deep as old people come on ; when freed from the teeth by extraction, they are some time after filled up by an osseous net-work, which at last becomes entirely



entirely solid, and as smooth as any other part of the bone; so that in a great many old jaws one cannot observe a vestige of the socket. But then the jaw becomes less, and much narrower (a).—Hence we may know why the lips and nose of edentulous people are much nearer than before the teeth were lost; while the lips either fall in towards the mouth, or stand prominent forwards.—When new teeth are protruded, new sockets are formed (b).—The lower edge of the chin and sides is smooth and equal, and is commonly called the *base* of the lower jaw.—The ends of the base, where the jaw turns upwards, are called its *angles*; the external surface of each of which has several inequalities upon it, where the *masseter* muscle is inserted; as the internal surface also has, where the *pterygoideus internus* is inserted, and a ligament extended from the *styloid* process of the temporal bone is fixed.

The processes are two on each side.—The anterior sharp thin *coronoid* ones have the *temporalis* muscles inserted into them.—The posterior processes or *condyles* \* terminate in an oblong smooth head, supported by a cartilage. The heads whose greatest length is transverse and whose convexity is turned forwards, are tipped with a cartilage, as the articulated parts of all other moved bones are.—The fore part of the root and neck of these *condyloid* processes are a little hollow and rough, where the external *pterygoid* muscles are inserted.

(a) Vesal. Anat. lib. 1. cap. 10.

(b) Fallop. Observ. anat.

\* Articulatorii.

The holes of the lower jaw are two on each side; one at the root of the process internally, where a large branch of the third branch of the fifth pair of nerves enters with an artery, and a vein returns. A small sharp process frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament extended from the temporal bone is fixed (*a*); which saves the nerve and vessels from being too much pressed by the *pterygoid* muscles. — From the lower end of this hole, either a small superficial canal or a furrow descends, where a branch of the nerve is lodged, in its way to the *mylohyoid* muscle and sublingual gland (*b*). — The other hole is external, at the confines of the chin, where branches of the nerve and blood vessels come out. — The canal betwixt these holes is formed in the middle of the substance of the bone, and is pierced by a great number of small holes by which the nerves and blood vessels of the *cancelli* and teeth pass. This canal is continued a little further than the external hole at the chin. — On account of the vessels and nerves in the lower jaw, fractures of it may be attended with dangerous symptoms.

The surface of the lower jaw is hard and smooth, except at the spongy sockets, where it is stronger than the upper jaw. — The internal substance is cellular, without any partition between the *cancelli* in its middle. — At the base, especially of the chin, where

N

Weitbrecht. Syndesmolog. fig. 32. 1.  
 Palfyn. Anat. chirurg. traite 5. chap. 6.

where this bone is most exposed to injuries, the solid sides of it are thick, compact, and hard.

The lower jaw generally receives the roots of sixteen teeth into its sockets, by *gomphoses*, and its *condyloid* processes, covered with cartilage, are articulated with the *temporal* bones in a manner that is not commonly described right: For, as was already mentioned in the description of the temporal bones, not only the fore part of the cavity between the *zygomatic*, *auditory*, and *vaginal* processes, but also the joining tubercle at the root of the *zygomatic* process of each *os temporum* is covered with smooth cartilage, for this articulation.—Here also an intermediate moveable cartilage is placed, which being thin in the middle and thick at the edges, is concave on both sides; and is connected so firmly by ligaments to each *condyle*, as to follow the motions of the *condyle*; and so loosely to the *temporal* bone, as readily to change its situation from the cavity to the tubercle, and to return again while the common ligament of the articulation affords space enough for such a change, to place backwards and forwards; but, likewise other ligaments of the joints by *ginglimma* strong and short at the sides, to confine the lateral motions.

When therefore the teeth of both jaws coincide, the *condyles* are lodged securely in the temporal cavities, but their motions on either side must be confined both by the firmness of the ligaments, and the rising borders which are on each side of the cavities.

When the jaw is brought directly forwards, the condyle and intermediate cartilages descend and advance forwards upon the tubercle.

—In this situation the lateral motions are a little more free than in the former one, in the want of rising brims to stop the condyles.

—When the fore-teeth of the lower jaw are moved forwards, and to a side, the condyle of the opposite side is either advanced in the cavity to the tubercle, while the condyle of the same side remains in the cavity; or both condyles are on the tubercles, when the jaw is moved obliquely to a side, the condyle of the side to which the motion is made is back from the tubercle to the cavity.

—When the mouth is opened by the descent of the lower jaw, the fore part of it, where the *masseter* muscles are fixed, is drawn backwards, as well as downwards, while resistance is made to the angles moving backwards by the *masseter* and *internal pterygoid* muscles, and, at the same time, the *external pterygoid* draw the condyles and their moveable cartilages forwards; and therefore, when the mouth is open, the condyles are carried forwards upon the tubercles, and the axis of motion of the jaw is a little above its angles. But in this situation there is less resistance, than in any other, to the condyles luxating forwards; a difficulty which seldom happens, except when people are gaping too wide; and therefore the common practice of nurses, who support the jaw of infants when they are yawning, is reasonable.

In.



In chewing there is a succession of the motions above described (a).

Here a general remark may be made, That where-ever moveable cartilages are found in joints, either the articulated bones are of such a figure, or so joined and fixed by their ligaments, that little motion would be allowed without such cartilages; or else some motions are necessary to the right use of the members, which the form of the articulation would not otherwise admit of. This will more fully appear after the other joints with such cartilages are described.

In a child born to the full time, the lower jaw is composed of two bones, connected by a thin cartilage in the middle of the chin, which gradually ossifies, and the two bones intimately unite.—In each of these bones there are five or six sockets for teeth as in the upper jaw.

After I have thus described the incasement of the teeth, the insertion of so many muscles of the tongue, and of the *os hyoides*, the connection of the membrane of the tongue to the maxillary bone, and the motions of this bone it is easy to see, that the lower jaw must be the principal instrument in manducation, deglutition, and speech.

The *TEETH* are the hard white bodies placed in the sockets of both jaws. The number is generally sixteen above, and as many

(a) For a more full account of this articulation, vide Edinburgh Medical essays and observ. vol. 1. art. 11. vol. 3. art. 13.—Memoires de l'acad. des sciences, 1740.

below ; though some people have more, others have fewer.

The broad thick part of each tooth which appears without the socket, is the *base* or body\*.

—The smaller processes sunk into the *maxilla* are the *roots* or *fangs*, which become gradually smaller towards the end farthest from the base, or are nearly conical, by which the face of their sides divides the pressure made at the bases, to prevent the soft parts, which at the small points of the sockets, to be hurt by such pressure. — At the place where the base ends, and the roots begin, there is generally a small circular depression, which some call the *neck* or *collar*.

Without the gums the teeth are covered with a membrane, and they are said to have a proper *periosteum* within the sockets ; but this is supplied by the reflected membrane of the gums ; which, after a good injection, may be evidently seen in a young subject, with the vessels from it penetrating into the substance of the teeth ; and it may be discovered in any tooth recently pulled, by macerating it in water. The adhesion of this membrane to the roots is strengthened by the small furrows observable on them.

Each tooth is composed of its *cortex*, or *enamel*, and an internal bony substance. The enamel has no cavity or place for marrow ; it is so solid and hard, that saws or files can with difficulty make impression on it. It is fixed upon the base, and gradually, as the roots

N 3

roots

prona.

Cowper. Anatom. explicat. tab. 92. fig. 7. lit. E.

roots turn smaller, becomes thinner, but proportionally to the difference of the size of the base and roots.——The fibres of this enamel are all perpendicular to the internal surface, and are straight on the base, but at the sides are arched with a convex part towards the roots (*a*); which makes the teeth resist the compression of any hard body between the jaws, with less danger of breaking these fibres than if they had been situated transversely. The spongy sockets in which the teeth are placed likewise serve better to prevent such an injury than a more solid base would have done.——Notwithstanding the great hardness of this enamel, it is wasted by manducation. Hence the sharp edges of some teeth are blunted, and made broad, while the rough surfaces of others are made smooth and flat, as people advance in life.

The bony part of the teeth has its fibres running straight, according to the length of the teeth. When it is exposed to the air, the breaking or falling off of the hard enamel it soon corrupts. And thence carious teeth are often all hollow within, when a very small part appears only externally.

The teeth have canals formed in their middle, wherein their nerves and blood-vessels are lodged; which they certainly need, being constantly wasted by the attrition they are subjected to in manducation, and for their future growth, not only after they first appear, but even in adults; as is evident when a tooth

(*a*) Havers *Osteolog. nov. disc.* 1.

ken out : For then the opposite one becomes longer, and those on each side of the empty socket turn broader ; so that when the jaws are brought together, it is scarce observable where the tooth is wanting (*a*).

The vessels are easily traced so long as they are in the large canal, but can scarce be observed in their distribution from that to the substance of the teeth of adults. Ruysch (*b*) however affirms, that after injection he could trace the arteries into the hardest part of the tooth : And Leewenhoek (*c*) suspected the fibres of the cortex to be vessels. In children I have frequently injected the vessels of the teeth as if as their base : And in such as are not entirely ossified, one can with a lucky injection fill so many vessels, as to make both the outside and inside of the cortical part appear perfectly red.

—This plentiful supply of vessels must expose the teeth to the same disorders that attack other vascular parts ; and such teeth as have the greatest number of vessels, must have the most numerous chances of being seized with these diseases.

Every root of each tooth has such a distinct canal, with vessels and nerves in it. These canals in the teeth with more than one root, are the nearer each other, as they approach the base of the tooth ; and at last are only separated by very thin plates, which being general-incompleat, allow a communication of all the

(*a*) Ingraf. de tumor, cap. 1. p. 24. 25. 26.

(*b*) Thesaur. 10 num. 27.

(*c*) Arcan. natur. continuat. epist. p. 3.



the canals; and frequently one common cavity only appears within the base, in which a pulpy substance composed of nerves and vessels is lodged. The condition therefore of the nerves here bears a strong analogy to that of the cutaneous nerves which serve for the sensation of touching.

The entry of the canals for these vessels is a small hole placed a little to a side of the extreme point of each root; sometimes, especially in old people, this hole is entirely closed up, and consequently the nerves and blood vessels are destroyed (a).

The teeth are seen for a considerable time in form of *mucus* contained in a membrane; afterwards a thin cortical plate, and some few osseous layers appear within the membrane with a large cavity filled with *mucus* in the middle; and gradually this exterior shell turns thicker, the cavity decreases, the quantity of *mucus* is lessened, and this induration proceeds till all the body is formed; from which the roots are afterwards produced.

In young subjects, different *flamina* or rudiments of teeth are to be observed. Those next the gums hinder ordinarily the deeper seated ones from making their way out, while these prevent the former from sending out roots, or from entering deep into the bony sockets of the jaws; by which they come to be less fixed.

Children are seldom born with teeth; but at two years of age they have twenty; and their number does not increase till they are about

(a) De la Hire Histoire de l'acad, des sciences, 1699,

at seven years old, when the teeth that first made their way through the gums are thrust out by others that have been formed deeper in the jaw, and some more of the teeth begin to cover themselves farther back in the mouth. About fourteen years of age, some more of the first crop are shed, and the number is increased.—This shedding of the teeth is of good use; for if the first had remained, they would have stood at a great distance one from another; because the teeth are too hard in their outer crust, to increase so fast as the jaws.

Whereas both the second layer, and the teeth that come out late, meeting, while they are soft, with a considerable resistance to their growth in length, from those situated upon them, necessarily come out broad, and fit to make that close guard to the mouth †, which they now form.

The teeth are joined to the sockets by *gomphosis*, and the gums contribute to fix them there; as is evident by the teeth falling out when the gums are any way destroyed, or made too spongy; as in the *scurvy* or *salivary*: whence some (a) class this articulation in the *syllarcosis*.

The uses of the teeth are to masticate our food, and to assist us in the pronunciation of several letters.

Though the teeth so far agree in their structure, yet, because of some things wherein they differ, they are generally divided into three kinds, viz. *incisores*, *canini*, and *molars*.

The

σπαγμος.

(a) Drake's Anthropolog. book 4. chap. 3.

The *incisores* \* are the four fore-teeth in each jaw, receiving their name from their office of cutting our aliment; for which they are excellently adapted, being each formed into a sharp-cutting edge at their *base*, by their fore-side turning inwards there, while they are slopped down and hollowed behind †; so that they have the form of wedges; and therefore their power of acting must be considerably increased.——Seeing in the action of the *incisores*, a perpendicular compression is only necessary, without any lateral motion, they are so firmly fixed in their sockets as the other teeth are, each having only one short root but that is broader from before backwards than to either side, to have the greatest strength where it is exposed to the strongest force applied to it (a).

The *incisores* of the upper jaw, especially the two middle ones ‡, are broader and longer generally than those of the under jaw.

In a new-born infant, the outer shell of the body of these teeth is only hardened.——Afterwards, when the *stamina* of two sets are formed, each has its own socket, those nearest the edge of the gums being placed more forward, and the others are lodged farther back within the jaw-bones.

\* Γελασῖνοι, τομίκοι, διχασῆρες, κτίνες, τομῆς, προσοδῆες, risorii, quaterii, primi, primores, anteriores, acuti.

† Ὀλμίσκος.

(a) Lettre sur l'osteologie, ascribed to Du Verney.

‡ Duales.

*Canini* \*, from the resemblance to dogs' fangs, are one on each side of the *incisores* in each jaw.—The two in the upper jaw are called *eye-teeth*, from the communication of nerves which is said to be betwixt them and the eyes.—The two in the lower jaw are named *angular* or *wike teeth*, because they support the angles of the mouth.

The *canini* are broader, longer, and stronger, than the *incisores*.—Their bases are formed to a sharp edge, as the *incisores* are; only at the edge rises into a point in the middle.—Each of them has generally but one long root, but sometimes they have two (a). The roots are crooked towards the end.—The *canini* of the upper jaw are larger, longer, and with more crooked roots, than those of the under jaw.—The form of their base is fit both for tearing and cutting, and the long crooked root in each makes it secure in the socket.

The *canini* of a child are in much the same condition as the *incisores* are.

The *dentes molares*, or *grinders* †, which have got their name because they grind our food, are generally five in each side of each jaw; in all twenty. Their bases are broader, more scabrous, and with a thinner cortical substance, than the other teeth. They have also more roots, and as these roots generally diverge from each other, the partitions of the sockets between them bear a large share of the great

*Kυνόδοντες, risorii, fractorii, collaterales, collumellares.*

(†) Fauchard, Chirurgien dentiste, chap. 1.

*Μολιται, γόμφοι, μύλοι, πλατείς, φρασῆρες, maxillares, molales, clavales, buccarum.*



great pressure they suffer, and hinder it to on their points (a).

The base of the first grinder has an ed pointed in the middle, on its outside, resembling the *canini*; from which it slopes inward till it rises again into a point.—It has generally but one root, which sometimes is long and crooked at its point.

The second *dens molaris* has two points at its base, rising near equally on its out and inside.—It has two roots, either separate or run together, but shorter than the root of the first.—These two anterior grinders are much smaller than the three that are placed farther back in the mouth.

The third and fourth are very broad in their bases, with four or five points standing out, and they have three or more roots.

The fifth, called commonly *dens sapientie*, from its coming through the gums later than the other grinders, has four points on its base, which is not so large as the base of the third and fourth, and its roots are less numerous.

The *incisores* of the upper jaw, being broader than those of the lower jaw, make the anterior grinders to be placed so much farther back than the lower ones, that when they are brought together, by shutting the mouth, the points of the grinders of the one jaw enter into the clefts or pressions of the opposite grinders, and they are all equally applied to each other, notwithstanding the inequality of their surface.

(a) Lettre sur l'osteologie.

• Σωφρονιστῆς, κραννῆς, ὀψιγόνος, sensus, intellectus, rotini, ætatem complentes, genuini, moderatores.

The numerous roots of the *dentes molares* event their loosening by the lateral pressure they suffer in grinding; and as the sockets in the upper jaw are more spongy, and the teeth more liable, by their situation, to fall out, the grinders there have more numerous and more separated roots than in the lower jaw. (b). The number however of the roots of the teeth of both jaws is very uncertain; sometimes they are more, sometimes fewer; frequently several roots are joined together; at other times they are all distinct. The disposition of such as are distinct is also various; for some the roots stand out straight, in others they are separate, and in others again they are hooked inwards. When the roots are united, we can still distinguish them, by remarking the number of small holes at their points, which determine the number of roots each tooth is to be reckoned to have.

At the time of birth, only two *dentes molares* in each jaw have begun to ossify, and are at little more than the base, which has several sharp points standing out from it.—The temporary grinders are placed more directly upon the internal set than the other two sets are; sometimes there is a piece of the bone of the jaws between the two sets; in other children, the two sets have no bone interposed between them.

From what has been said, the answers to the following queries may be given.

O

Why

Galen. de ossib. cap. 3.

Fauchard. Chirurg. dent. chap. 7.

Why are children subject to salivation, fever, convulsion, vomiting, purging, &c. when their teeth are breeding or cutting the gums.

Why in children do the *dentes incisores* first cut the gums, the *canini* next, and *molars* last?

Why do children shed their teeth?

Wherefore have these *temporaneous* teeth generally no roots, or very small ones?

Why have these first teeth sometimes roots and that more frequently in teeth pulled by art than in those which are shedded by nature (a)?

Why do these roots frequently come outwards through the gums?

Whence come *butter* or *buck* teeth?

How do these teeth sometimes go into the natural row with the others, after pulling a rotten tooth near them?

How have some people got two rows of teeth in one or both jaws (b)?

Why do the teeth of old people loosen, and then drop out entire?

Whence arise the new sets of teeth which several old people obtain (c)?

Why are not the gums of toothless old people torn by the hard sockets in chewing?

Why are the teeth insensible when slightly filed or rasped?

How come they to be sensible of heat or cold, to be set on edge by acids, or to grow

(a) Fauchard. Chirurgien dentiste, p. 7.

(b) Blas. Comment, ad Vesling. Syntagm. cap. 1. 3.

(c) Hoffman. in Van. Horn. microcosm, p. 38.

uneasy sensation when gritty or sandy substances are rubbed between them?

Why does a person who has a pained tooth imagine it longer than any other?

What is the reason of some persons dying convulsed, upon rasping or filing down an overgrown tooth (a)?

How do the teeth break and moulder away without any pain in some people and not in others?

What parts are affected in the tooth-ach?

What are the causes of the tooth-ach?

May worms be reckoned among these causes?

Why are the *dentes molares* most subject to that disease?

In what different manners ought the several classes of teeth to be extracted when such an operation is necessary?

Whence proceeds the violent obstinate *hemorrhagy* which sometimes attends the drawing of teeth (c)?

Why is it more difficult and dangerous to draw the eye teeth than any other?

What makes it impossible frequently to draw *manders* without bringing away part of the jaw-bone with them, or breaking the fangs?

O 2

Why

(a) Bartholin. Anat. reformat. lib. 4. cap. 12.

(b) Jacob. in Act. Hafn. vol. 5. obs. 107. — Pechlin. Ob-  
serv. medic. lib. 2. obs. 36. — Bartholin. Hist. medic. cent. 3.  
96.

(c) Pare. livre 6 chap. 2. — Rolsinc. lib. 2. cap. 27. &  
— Moebii Fundam. medicin. cap. 9. — Ephemerid. Ger-  
man. dec. 1. ann. 3. obs. 319. — Fauchard. Chirurg.  
iste, tom. 1. chap. 23. observ. 7.



Why do teeth soon replaced after being extracted, become again fixed in the sockets (a)

According to the division made of the skeleton, we should now proceed to the description of the trunk of the body. But must first consider a bone, which cannot well be said to belong to either the head or the trunk; nor is it immediately joined to any other, and therefore very seldom preserved with skeletons. However, it is generally described by authors after the bones of the face: In obedience therefore to the prevailing method, I shall next examine the structure of

The *OS HYOIDES*\*, which is situated horizontally between the root of the tongue and the *larynx*. It is properly enough named *hyoides*, from the resemblance it bears to the Greek letter *v*, and may, for a clearer demonstration of its structure, be distinguished into *body*, *cornua*, and *appendices*.

The body is the middle broad part, convex before, and hollow behind.——The confore-part is divided into two, by a ridge, to the middle of which the *mylo-hyoidei*, into the sides the *styla-hyoidei*, muscles are inserted.——Above the ridge, the bone is horizontal, but pitted in the middle by the insertion of the two *genio-hyoidei* muscles, a little hollowed more laterally by the *glossi*.——Below the ridge, it is convex, but

(a) De la Motte Chirurgie, tom. 1. chap. 4. obs. 2. — Fauchard, Chirurgien dentiste, tom. 1. chap. 29.

\* *Hypothyloides* *Lambdoides*, *παρὰ τὴν, ἐκφυγμένην* *gutturis*, *os linguæ*, *os morsus Adami*, assessor, or *bicorne*.

de flattened in the middle by the *sterno hyoidei*,  
 and pitted more externally by the *coraco-hyoi-*  
 —The concavity behind faces backwards  
 and downwards to receive the *thyroid* cartilage,  
 when the *larynx* and the *os hyoides* are pulled  
 towards each other by the action of the *sterno-*  
*hyoidei* and *hyothyroidei* muscles; and to its up-  
 per edge, the ligamentous membranes of the  
*glottis*, tongue, and *thyroid* cartilage, are  
 fixed.

The *cornua* of the \* *os hyoides* are stretched  
 backwards from each side of its body, where  
 a small furrow points out the former se-  
 paration; for in young subjects, the body and  
*cornua* are not one continued substance, as they  
 become afterwards to be in adults. — These *cor-*  
*na* are not always straight, nor of equal  
 length; their two plain surfaces stand obliquely  
 dipping from above outwards and downwards.  
 Into the external, the *cerato glossus* is in-  
 serted above, and the *thyro-hyoideus* muscle be-  
 neath; and to the one behind, the ligamentous  
 membrane of the tongue and *larynx* adheres.  
 The *cornua* of the *os hyoides* becomes gradually smaller,  
 and is extended from the base; but ends in a  
 small tubercle, from which a moveable carti-  
 lage stands out, which is connected to the up-  
 per process of the *cartilago thyroidea*.

Where the body of the *os hyoides* joins on  
 one side with its *cornua*, a small styloform  
 process, called *appendix* †, rises upwards and  
 forwards, into which the *musculi stylo-hyoidei*  
 are fixed, and part of the *hyo-glossi* muscles are fix-  
 ed.

O 3.

*Crura, latera inferiora.*

*Crura superiora, latera superiora, ossa graniformia.*

ed. From each of them a ligament is sometimes extended to the *styloid* processes of the temporal bones, to keep the *os hyoides* from being drawn too much forwards or downwards. The part of this ligament next to these processes sometimes forms into several cartilages which afterwards ossify in old people. *Ruyssch* (a) says that he has seen this ossification continued as far up as the styloid processes, which were therefore joined to the *os hyoides* by *ankylosis*.

The substance of the *os hyoides* is cellular but covered with a firm external plate, which is of sufficient strength to bear the actions of so many muscles as are inserted into it.

It is not articulated with any bone of the body, except by means of the muscles and ligaments mentioned.

The use of the *os hyoides*, is to serve as a solid lever for the muscles to act with, in raising or depressing the tongue and larynx, in enlarging and diminishing the capacity of the fauces.

At birth, this bone is in a cartilaginous state excepting a small point of bone in the middle of its body, and in each of the *cornua*. The *appendices* frequently remain cartilaginous many years.

(a) *Advers. anat. dec. 3. § 9.*

## OF THE TRUNK.

THE TRUNK consists of the *spine*, *pelvis*, and *thorax*.

The *SPINE* \* is the long pile of bones extended from the *condyles* of the *occiput* to the end of the rump. It somewhat resembles two unequal pyramids joined in a common base. It is not, however, streight; for its upper part being drawn backwards by strong muscles, it gradually advances forewards, to support the *œsophagus*, vessels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forewards, to support the *viscera* of the *abdomen*. It afterwards turns backwards, for the enlargement of the *vis*. And, lastly, it is reflected forewards, for sustaining the lowest great gut.

The *spine* is commonly divided into *true* and *false vertebrae*; the former constituting the long upper pyramid, which has its base below, while the *false vertebrae* make the shorter lower pyramid, whose base is above.

The *TRUE VERTEBRÆ* † are the twenty-four upper bones of the *spine*, on which the several motions of the trunk of our bodies are performed; from which use they have justly their name.

Each of these *vertebrae* is composed of its body and processes.

The

\* Ταχὺς νῆτορ ἀκανθα, ἰίρα σύριγξ, σωλην, tergum, hominis carina.

† Στροφαῖς, σπόφυγγις, spondyli, ossa orbiculata, ossa vertebrae, verticulae.



The body is the thick spongy fore-part which is convex before, concave backwards, horizontal and plain in most of them above and below.—Numerous small holes, especially on the fore and back part of their surface, give passage to their vessels, and allow the ligaments to enter their substance.—The edges of the body of each *vertebra* are covered, especially at the fore-part, with a ring of bone firmer and more solid than the substance of the body any where else. These rings seem to be joined to the *vertebra* in the form of *epiphyses*, but are alledged by some (*a*) to be the ligaments ossified. They are of great use in preventing the spongy bodies from being broken in the motions of the trunk.

Between the bodies of each two adjoining *vertebra*, a substance between the nature of ligament and cartilage is interposed; which seems to consist of concentrical curve fibres when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decussating each other (*b*).—The outer part of the intervertebral ligaments is the most solid and hard; and they gradually become softer till they are almost in the form of glairy liquor in the center; and therefore these substances were not improperly called *mucous ligaments* by the ancients (*c*). The external fibrous part of each is capable of being greatly extended, and of being compressed in

(*a*) Fallop. Observat. anatom.

(*b*) Blancard, Anat. reform. cap. 32.—Weitbrecht, Synonymolog. sect. 4. § 15.

(*c*) Galen, de usu, part. lib. 12. cap. 16.

very small space, while the middle fluid part is incompressible, or nearly so; and the parts of this ligament between the circumference and center approach in their properties either, in proportion to their more solid or more fluid texture. The middle point is therefore a *fulcrum*, or *pivot*, on which the motion of a ball and socket may be made, with a gradual yielding of the substance of the ligament, in which ever direction our spines are moved, as saves the body from violent shocks, and their dangerous consequences (c).

—This ligamento-cartilaginous substance is only fixed to the horizontal surfaces of the bodies of the *vertebrae*, to connect them, in which it is assisted by a strong membranous ligament, which lines all their concave surface, by still a stronger ligament that covers all their anterior convex surface.

We may lay it down as a general rule, notwithstanding some exceptions, That the *bodies* of the *vertebrae* are smaller, and more solid above, but as they descend, they appear larger and more spongy; and that the cartilages between them are thick, and the surrounding ligaments strong in proportion to the largeness of the *vertebrae*, and to the quantity of motion they perform: By which disposition, the great weight is supported on the broadest best secured base, and the middle of our body is allowed a large and secure motion.

From each side of the body of each *vertebra* a bony bridge is produced backwards, and outwards; from the posterior end of which, one slanting

slanting process rises and another descends; the smooth, and what is generally the flattest side of each of these four processes, which are called the *oblique*\*, is covered with a smooth cartilage; and the two lower ones of each *vertebra* are fitted to, and articulated with the two upper or ascending oblique processes of the *vertebra* below, having their articular ligaments fixed to the rough line round their edges.

From between the oblique processes of each side the *vertebra* is stretched out laterally to a process that is named *transverse*.

From the back-part of the roots of the oblique, and of the transverse process of each side, a broad oblique bony plate is extended backwards, where these meet, the seventh process of the *vertebra* takes its rise, and stretches out backwards: This being generally sharp pointed and narrow edged, has therefore been called *spinal* process; from which this whole chain of bones has got its name.

Besides the common ligament which lines the internal surface of the spinal processes, well as of the bodies, there are particular ligaments that connect the bony bridges and processes of the contiguous *vertebra* together.

The substance of the processes is considerably stronger and firmer, and has a thicker external plate than the bodies of the *vertebra* have.

The seven processes form a concavity on their fore-part, which, joined to the one on the back-part of the bodies, makes a great hole, and the holes of all the *vertebra* form a

\* *Articulatorii, minimi,*

conduit \*, for containing the *spinal marrow*.—In the upper and lower edge of each *vertebra*, there is a notch. These are so fitted to each other in the contiguous *vertebrae*, as to form a round hole in each side between each two *vertebrae*, through which the *spinal marrow* and its blood vessels pass.

The articulations then of these *true vertebrae* are plainly double; for their bodies are joined by the intervening cartilage above described, their oblique processes being tipped with cartilages, are so connected by their ligaments, as to allow a small degree of motion in all sides. Hence it is evident, that their power of motion is altered in different positions of the trunk: For when we bow forwards, the upper moved part bears entirely on the bodies of the *vertebrae*: If we bend back, the oblique processes support the weight: If we rest on one side, we rest upon the oblique processes of that side and part of the bodies: If we stand erect, all the bodies and oblique processes have their share in our support. Hence it follows, 1. That because the joints of which the spine is composed are so numerous, the *spinal marrow*, nerves, blood-vessels, are not liable to such compression and stretching in the motion of the trunk of the body, as they would otherwise be, since few *vertebrae* must be concerned in every motion of the spine; and therefore a very small figure is made at the conjunction of any two

\* σπιγγή, σπλήν, *Canalis*,

two *vertebrae* (a). 2. That an erect posture is the surest and firmest, because the surface of contact of the *fulcra* is largest, and the weight is most perpendicular to them (b). 3. That the muscles which move the spine act with greater force in bringing the trunk to an erect posture, than in drawing it to any other: for bending forwards, backwards, or to a side, the muscles which perform any of these actions are nearer the center of motion; consequently the lever with which they act is shorter, than when the center of motion is on the part of the *vertebra*, opposite to that where these muscles are inserted; which is the case in raising the trunk. This is extremely necessary; for in the deflections of the spine from a perpendicular bearing, the weight of the body inclines it which way we design; whereas in raising us erect, this great weight must be more than counteracted. 4. In calculating the force exerted by the muscles which move the spine, we should always make allowance for the action of the cartilages between the *tebrae*, which, in every motion from an erect posture, must be stretched on one side, compressed on the other, to both which they resist; whereas, in raising the trunk, the cartilages assist by their springy force (c). We are hence naturally led into the reason why our height of stature increasing in the

(a) Galen de usu part. lib. 12. cap. 12.

(b) Paaw de ossib. part. 2. cap. 2.

(c) Borelli, de motu animal. pars 1. schol. ad prop. Parent. Histoire de l'acad. des sciences, 1702.



g, and diminishing at night (a): for the intermediate cartilages of the *vertebrae* being pressed all day long by the weight of our bodies, become more compact and thin in the evening; but when they are relieved from this pressure in the night, they again expand themselves to their former thickness; and seeing the bulk of any part must vary according to the different distension or repletion of the vessels composing it, we may understand how we become taller after a plentiful meal, and decrease after fasting or evacuations (b). 6. From the different articulations of the bodies, the oblique processes of the *vertebrae*, and the different strength of the ligaments, it is plain, they are formed so as to allow much larger motion forwards than backwards; this last being of much less use, and might be dangerous, by overstretching the large blood-vessels that are contiguous to the bodies of the *vertebrae*. 7. The intervertebral cartilages shrink as they become more solid by age, is the reason why old people generally bow forwards, and cannot raise their bodies to such an erect posture as they had in their youth. The true *vertebrae* serve to give us an erect posture; to allow sufficient and secure motion of the head, neck, and trunk of the body, to support and defend the bowels, and other soft parts.

At the ordinary time of birth, each *vertebra* consists of three bony pieces, connected by  
P cartilages;

Wasse Philosoph. transact. numb. 383. art. 1.  
 Abbe Fontenu Histoire de l'acad. des sciences 1725.  
 Galen, de usu part. lib. 1. cap. 16.

cartilages ; to wit, the *body*, which is not fully ossified, and a long crooked bone on each side ; on which we see a small share of the bony bridge, the oblique processes complete the beginning transverse processes, and the oblique plate, but no spinal processes, so that the teguments are in no danger of being hurt by the sharp ends of these spinal processes ; while a child is in its bended posture in the womb, nor while it is squeezed in the birth.

From this general mechanism of the spine an account is easily deduced of all the different preternatural curvatures which the spine is capable of : for if one or more *vertebrae*, their cartilages, are of unequal thickness on opposite sides, the spine must be reclined on to the thinner side ; which now sustaining the greatest share of the weight, must still be more compressed, consequently hindered from extending itself in proportion to the other side, which, being too much freed of its burden, has liberty to enjoy a luxuriant growth. The causes on which such an inequality of thickness in different sides of the *vertebrae* depends may vary : for either it may be owing to an over-distension of the vessels of one side, from whence a preternatural increase of the thickness of that part ; or which more commonly is the case, it may proceed from an obstruction of the vessels, by which the application of proper nourishment to the bony substance is hindered, whether that obstruction depends on the faulty disposition of the vessels or fluids ; or if it is produced by an unequal mechanical pressure, occasioned by a paral-

weakness of the muscles and ligaments, or by spasmodic over-action of the muscles on any part of the spine, or by people continuing long, or putting themselves frequently into any posture declining from the erect one: In all these cases one common effect follows, to wit; the *vertebrae*, or their cartilages, or both, turn back on that side where the vessels are free; and remain thin on the other side where the vessels are straitened or obstructed.—When any morbid curvature is thus made, a second turn, but in an opposite direction to the former, must be formed; both because the muscles on the convex side of the spine being stretched, must have a stronger natural contraction to draw the parts to which their ends are fixed, and because the patient makes efforts to keep the center of gravity of the body perpendicular to its base, that the muscles may be relieved from a constant violent contraction, which always creates uneasiness and pain.

When once we understand how these crookings are produced, there is little difficulty in forming a just prognosis; and a proper method of cure may be easily contrived, which may vary as to the internal medicines, according to the different causes on which the disorder depends: But one general indication must be pursued by surgeons; which is, to counteract the bending force, by increasing the compression on the convex part of the curvature, and diminishing it on the concave side. The manner of executing which in particular cases must be different, and requires a very accurate examination.

mination of the circumstances both of the disease and patient. In many such cases, I have found some simple directions, as to postures which the patient's body should be kept, of very great advantage.

Though the *true vertebrae* agree in the general structure which I have hitherto described yet because of several specialities proper to each particular number, they are commonly divided into three classes, viz. *cervical*, *dorsal*, and *lumbar*.

The *cervical* \* are the seven uppermost *vertebrae*; which are distinguished from the rest by these marks.—Their bodies are smaller and more solid than any others, and flattened on the fore-part, to make way for the *oesophagus*; or rather this flat figure is owing to the pressure of that pipe, and to the action of the *longi colli* and anterior *recti* muscles.—They are also flat behind; where small processes to which the internal ligaments are fixed.—The upper surface of the body of each *vertebra* is made hollow, by a slanting thin process which is raised on each side:—The lower surface is also excavated, but in a different manner; for here the posterior edge is raised a little, and the one before is produced a considerable way.—Hence we see how the cartilages between those bones are firmly connected and their articulations are secure.

The cartilages between these *vertebrae* are thick, especially at their fore-part; which

\* Τραχηλις, α'υχίς, collis.

reason why the *vertebra* advance foreward they descend, and have larger motion.

The oblique processes of these bones of the neck more justly deserve that name than those of any other *vertebra*. They are situated obliquely; the upper ones having their smooth almost flat surfaces facing obliquely backwards and upwards, while the inferior oblique processes have these surfaces facing obliquely forwards and downwards.

The transverse processes of these *vertebra* are formed in a different manner from those of any other bones of the spine: For besides the common transverse process rising from between the oblique processes of each side, there is a second one that comes out from the side of the body of each *vertebra*; and these two processes, after leaving a circular hole for the passage of the cervical artery and vein, unite, and are considerably hollowed at their upper ends with rising sides, to protect the nerves as they pass in the hollow; and at last each side terminates in an obtuse point, for the insertion of muscles.

The spinal processes of these cervical bones are nearly straight backwards, are shorter than those of any other *vertebra*, and are forked and double at their ends; and hence allow a convenient insertion to muscles.

The thick cartilages between the bodies of the cervical *vertebra*, the obliquity of their processes, and the shortness and horizontal position of their spinal processes, all concur to allow them large motion.



The holes between the bony cross bridges for the passage of the nerves from the *spinal marrow*, have their largest share formed in the lowest of the two *vertebrae*, to which they are common.

So far most of the cervical *vertebrae* agree, but they have some particular difference which oblige us to consider them separately.

The first, from its use of supporting the head, has the name of *atlas* \*; and is also called *epistrophe*, from the motion it performs on the second.

The *atlas*, contrary to all the other *vertebrae* of the spine, has no body; but, instead of it, there is a bony arch.—In the convex fore-part of which, a small rising appears, where the *musculi longi colli* are inserted; and on each side of this protuberance, a small cavity may be observed, where the *recti interni* *muscles* take their rise.—The upper and lower parts of the arch are rough and unequal, where the ligaments that connect this *vertebra* to the *occipitis*, and to the second *vertebra* are fixed.—The back-part of the arch is concave, smooth, and covered with a cartilage, in a recent subject, to receive the tooth-like process of the second *vertebra*.—In a first *vertebra* from which the second has been separated, a hollow makes the passage for the *spinal marrow*, to seem much larger than it really is: on each side of it a small rough sinuosity may be remarked, where the ligaments going to the sides of the tooth-like process of the following *vertebra*

*vertebra* are fastened; and on each side, a small rough protuberance and depression is observable, where the transverse ligament, which secures the tooth-like process in the sinuosity, is fixed, and hinders that process from injuring the *medulla spinalis* in the flexions of the head.

The *atlas* has as little spinal process as body; instead thereof, there is a large bony arch, that the muscles which pass over this *vertebra* at that place might not be hurt in extending the head. On the back and upper part of this arch there are two depressions, where the *recti postici minores* take their rise; and at the lower part are two other sinuosities, to which the ligaments which connect this bone to the following one are fixed.

The superior oblique processes of this *atlas* are large, oblong, hollow, and more horizontal than in any other *vertebra*.——They rise more in their external than internal brim; by which their articulations with the *condyloid* processes of the *os occipitis* are firmer.——Under the external edge of each of these oblique processes, is the *fossa*, or deep open channel, in which the vertebral arteries make the circuit, as they are about to enter the great *foramen* of the occipital bone, and where the eighth pair of nerves goes out.——In several

dissections, I have seen this *fossa* covered with bone.——The inferior oblique processes extending from within outwards and downwards, are large, concave, and circular. So that this *vertebra*, contrary to the other six, receives the bones with

with which it is articulated both above and below.

The transverse processes here are not much hollowed or forked, but are longer and larger than those of any other *vertebra* of the neck for the origin and insertion of several muscles of which those that serve to move this *vertebra* on the second have a considerable lever to act with, because of the distance of their insertion from the *axis* of revolution.

The hole for the *spinal marrow* is larger in this than in any other *vertebra*, not only on account of the *marrow* being largest here, but also to prevent its being hurt by the motions of this *vertebra* on the second one.—This large hole, and the long transverse processes, make this the broadest *vertebra* of the neck.

The *condyles* of the *os occipitis* move forwards and backwards in the superior oblique processes of this *vertebra*; but from the figure of the bones forming these joints, it appears that very little motion can here be allowed on either side; and there must be still less circular motion.

In new-born children this *vertebra* has only the two lateral pieces ossified; the arch, which it has at its fore-part instead of a body, being cartilaginous.

The second *vertebra colli* is called *dentata* from the tooth-like process on the upper part of its body. Some authors call it *epistrophe* but improperly, since this designation is only applicable to the first, which moves on this on an axis.

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The body of this *vertebra* is somewhat of a pyramidal figure, being large, and produced downwards, especially at its fore side, to enter into a hollow of the *vertebra* below; while the upper part has a square process with a small protuberance standing out from it. This it is that is imagined to resemble a tooth \*, and has given name to the *vertebra*.—The side of this process, on which the hollow of the anterior arch of the first *vertebra* plays, is convex, smooth, and covered with a cartilage; and it is of the same form behind, for the ligament, which is extended transversely from one rough protuberance of the first *vertebra* to the other, and is cartilaginous in the middle, to move on it.—A ligament likewise goes out in an oblique transverse direction, from each side of the *processus dentatus*, to be fixed at its other end to the first *vertebra*, and to the occipital bone; and another ligament rises up from near the bottom of the process to the *os occipitis*.

The superior oblique processes of this *vertebra dentata* are large, circular, very nearly in a horizontal position, and slightly convex, and are adapted to the inferior oblique processes of the first *vertebra*.—A moveable cartilage is by some authors to be interposed between the oblique processes of the first and second *vertebra*; but I could never find it.——The inferior oblique processes of this *vertebra dentata* answer exactly to the description given of the common to all the cervical *vertebrae*.

The

Conoides, pyrenoides, odontoides.

The transverse processes of the *vertebra dentata* are short, very little hollowed at the upper part, and not forked at their ends; and the canals through which the cervical arteries pass, are reflected outwards about the middle substance of each process; so that the course of these vessels may be directed towards the transverse processes of the first *vertebra*.—Had this curvature of the arteries been made in a part so moveable as the neck is, while the vessels were not defended by a bone, and fixed to the bone, scarce a motion could have been performed without the utmost hazard of compression, and a stop put to the course of the liquor with all its train of bad consequences. Hence we observe this same mechanism several times made use of, when there is any occasion for a sudden curvature of a large artery. This is the third remarkable instance of it we have seen. The first was the passage of the carotid through the *temporal* bones; and the second was that lately described in the vertebral artery turning round the oblique processes of the *vertebra*, to come at the great hole of the occipital bone.

The spinal process of this *vertebra dentata* is thick, strong, and short, to give sufficient origin to the *musculi recti majores*, and *obliqui inferiores*, and to prevent the contusion of the spine and other muscles in pulling the head back.

This second *vertebra* consists, at the base of the skull, of four bony pieces: For, besides the occipital bone which I already mentioned as common to the *vertebra*, the tooth-like process of the *occipital* bone is begun at this time to be ossified in

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See Eu



middle, and is joined as an appendix to the body of the bone.——Lest this appendix be added or displaced, nurses ought to keep the heads of new-born children from falling too far backwards by *stay-bands*, or some such means, till the muscles attain strength sufficient to prevent that dangerous motion.

When we are acquainted with the structure and articulations of the first and second *vertebra*, and know exactly the strength and condition of their ligaments, there is no difficulty in understanding the motions that are performed upon or by the first; though this subject was formerly matter of hot dispute among some of the greatest anatomists (*a*). It is not of my purpose at present to enter into a detail of the reasons advanced by either party; but to explain the fact, as any one may see who will remove the muscles, which, in a recent subject, hinder the view of these two vertebrae, and then will turn the head into all the different positions it is capable of. The head will then be seen to move forwards and backwards on the first *vertebra*, as was already said, while the *atlas* performs the *circumgyratio* upon the second *vertebra*; the inferior oblique process of the first *vertebra* shuffling easily in a circular way on the superior oblique processes of the second, and its body or anterior arch making a rotation on the tooth-like process, by which the perpendicular ligament that is fixed from the point of the tooth-like process to the occipital bone is twisted, while the lateral ligaments that fix the *processus dentatus* to

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See Eustach, de motu capitis.

to the sides of the first *vertebra*, and to the *occipitis*, are very differently affected; for the one upon the side towards which the face is turned by the *circumgyratio*, is much shortened and lax, while the opposite one is stretched and made tense, and yielding at last no more, prevents the head from turning any further round on this *axis*. So that these lateral ligaments are the proper *moderators* of the *circumgyratio* of the head here, which must be larger or smaller, as these ligaments are weaker or stronger, longer, or shorter, and more or less capable of being stretched.—Besides the rotation on this *axis*, the first *vertebra* can move a small way to either side; but is prevented from moving backwards and forwards by its anterior arch, and by the cross ligaments which are both closely applied to the tooth-like process. Motion forwards here would have been of very bad consequence, as it would have brought the beginning of the *spinal marrow* upon the point of the tooth-like process.

The rotatory motion of the head is of great use to us on many accounts, by allowing us to apply quickly our organs of the senses to different objects: and the *axis* of rotation was altogether proper to be at this place; for if it had been at a greater distance from the head, the weight of the head, if it had at any time been removed from a perpendicular bearing to the face, would have made it a very moveable joint, and thereby had acted as a long lever, would have broke the ligaments at every turn inconsiderately performed; or these ligaments must have been formed much stronger than could have been con-

to such small bones. Neither could this circular motion be performed on the first *vertebra* without danger, because the immoveable part the *medulla oblongata* is so near, as, at each turn, the beginning of the *spinal* marrow would have been in danger of being twisted, of suffering by the compression this would be made on its tender fibrils.

It is necessary to observe, that the *lateral* or *rotator* ligaments confine so much the motion of the first *vertebra* upon the second, that, though this joint may serve us on several occasions, yet we are often obliged to turn our bodies farther round, than could be done by this joint alone, without the greatest danger of twisting the spinal marrow too much, and also luxating the oblique processes; therefore, large turns of this kind, the rotation is assisted by all the *vertebrae* of the neck and loins; if this is not sufficient, we employ most of the joints of the lower extremities.—This combination of a great many joints towards the performance of one motion, is also to be observed in several other parts of the body; notwithstanding such motions being generally to be performed by some single joint on-

The third *vertebra* of the neck is by some called *axis*; but this name is applied to it on much less reason than to the second.—This third, and the three below, have nothing particular in their structure; but all their parts come under the general description formerly given, each of them being larger as they descend.

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The

The seventh \* *vertebra* of the neck is new to the form of those of the back, having the upper and lower surfaces of its body less than the others :—The oblique processes are more perpendicular ;—neither spinal nor transverse processes are forked.—This seventh and the sixth *vertebra* of the neck have a hole in each of their transverse processes more frequently divided by a small cross bridge, that goes between the cervical vein and artery, than any of the other *vertebrae*.

The twelve *dorsal* † may be distinguished from the other *vertebrae* of the spine by the following marks.

Their bodies are of a middle size, between those of the neck and loins ;—they are more convex before than either of the other two sorts ; and are flattened laterally by the pressure of the ribs, which are inserted into small cavities formed in their sides. This flattening on the sides, which makes the figure of these *vertebrae* almost an half oval, is of good use ; it affords a firm articulation to the ribs, allows the *trachea arteria* to divide at a small angle, and the other large vessels to run secure from the action of the vital organs.—These bodies are more concave behind than any of the other two classes.—Their upper and lower surfaces are horizontal.

The cartilages interposed between the bodies of these *vertebrae* are thinner than in any other

\* Atlas quibusdam, maxima, magna *vertebra*, promissa

† Θωρακος, μετασπινυ, γατν, ὑποτραχήλιον, antisterni, thoris, tergi.

the *true vertebrae*; and contribute to the cavity of the spine in the thorax, by being nearest at their fore-part.

The *oblique processes* are placed almost perpendicular; the upper ones slanting but a little forwards, and the lower ones slanting as much backwards.—They have not as much convexity or concavity as is worth remarking.—Between the oblique processes of opposite sides, several sharp processes stand out from the upper and lower parts of the plates which join to form the spinal process; into these sharp processes strong ligaments are fixed, for connecting the *vertebrae*.

The *transverse processes* of the *dorsal vertebrae* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the pressure of the ribs, the ends of which are inserted into a depression near the end of these processes.

The *spinal processes* are long, small pointed, sloping downwards and backwards; from the upper and back-part a ridge rises, which is received by a small channel in the fore-part of the spinal process immediately above, which is connected to it by a ligament.

The *conduit* of the *spinal marrow* is here circular, but, corresponding to the size of the *vertebra*, is smaller than in any of the other *vertebrae*, and a larger share of the holes in the *vertebrae* bridges, for the transmission of the nerves, is formed in the *vertebra* above, than in the one below.

The connection of the *dorsal vertebrae* to the ribs, the thinness of their cartilages, the



erect situation of the oblique processes, the length, sloping, and connection of the spinous processes, all contribute to restrain these *vertebrae* from much motion, which might disturb the actions of the heart and lungs; and, in consequence of the little motion allowed here, the *intervertebral* cartilages sooner shrivel, becoming more solid: And therefore, the remarkable curvature of the spine observed as people advance to old age, is in the least stretched *vertebrae* of the back; or old people first become round-shouldered.

The bodies of the four uppermost *dorsal vertebrae* deviate from the rule of the *vertebrae* becoming larger as they descend; for the first of the four is the largest, and the others below gradually become smaller, to allow the *trachea* and large vessels to divide at small angles.

The two uppermost *vertebrae* of the back instead of being very prominent forwards, are flattened by the action of the *musculi longissimi* and *recti majores*.

The proportional size of the two little depressions in the body of each *vertebra* for receiving the heads of the ribs, seems to vary in the following manner; the depression on the upper edge of each *vertebra* decreases far down as the fourth, and after that increases.

The transverse processes are longer in the lower *vertebra* to the seventh or eighth, than their smooth surfaces, for the tubercles of the ribs, facing gradually more downwards; afterwards as they descend they become flatter.

and the smooth surfaces are directed more upwards.

The spinous processes of the *vertebrae* of the back become gradually longer and more slanting from the first, as far down as the eighth or ninth *vertebra*; from which they manifestly turn shorter and more erect:

The first \* *vertebra*, besides an oblong hollow at its lower edge, that assists in forming the cavity wherein the second rib is received, has the whole cavity for the head of the first rib formed in it.

The second has the name of *axillary* †, without any thing particular in its structure.

The eleventh ‡ often has the whole cavity for the eleventh rib in its body, and wants the smooth surface on each transverse process.

The twelfth || always receives the whole head of the last rib, and has no smooth surface on its transverse processes, which are very short. — The smooth surfaces of its inferior oblique processes face outwards as the *lumbar*.

— And we may say, in general, that the lower *vertebrae* of the back lose gradually their resemblance to those of the neck, and the upper ones come nearer to the figure of the *lumbar*.

The articulation of the *vertebrae* of the back with the ribs, shall be more particularly considered after the ribs are described. Only it

Q. 3. may

Λογία, gutturalis.

Μασχαλιστήρ

Ἀψίπης, in neutram partem inclinans.

Διασπαστήρ, præcingens.

may be proper now to remark, that the ligaments which serve that articulation assist in connecting the *vertebrae*.

The lowest order of the *true vertebrae* is the *lumbar* \*, which are five bones, that may be distinguished from any others by these marks.

1. Their bodies, though of a circular form at their fore-part, are somewhat oblong from one side to the other; which may be occasioned by the pressure of the large vessels, the *aorta* and *cava*, and of the *viscera*. The *epiphyses* on their edges are larger, and therefore the upper and lower surfaces of their bodies are more concave than in the *vertebrae* of the back.
2. The cartilages between these *vertebrae* are much the thickest of any, and render the spine convex within the *abdomen*, their greatest thickness being at their fore-part.
3. The oblique processes are strong and deep; those in opposite sides being almost placed in parallel planes; the superior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of these *vertebrae* receives the one above it, and is received by the one below; which is not so evident in the other two classes already described.
4. Their transverse processes are small, long, and almost erect, for allowing large motion to each bone, and sufficient insertion to muscles, and for supporting and defending the internal parts.
5. Betwixt the roots of the superior oblique and transverse processes, a small protuberance may be observed.

\* Οσφυός ἱεῦρος, φαιών, *renum, lumborum*.

here some of the muscles that raise the trunk of the body are inserted. 6 Their spinal processes are strong, straight, and horizontal, with broad flat sides, and a narrow edge above and below; this last being depressed on each side of the muscles. And at the root of these edges, we see rough surfaces for fixing the ligaments. The canal for the numerous cords, called *medulla equina*, into which the spinal marrow divides, is rather larger in these bones than that which contains that marrow in the *vertebrae* of the back. 8. The holes for the passage of the nerves are more equally formed out of both the contiguous *vertebrae* than in the other classes; the upper one furnishes however the larger share of each hole.

The thick cartilages between these *lumbar vertebrae*, their deep oblique processes, and their short spinal processes, are all fit for allowing great motion; though it is not so great as that which is performed in the neck; which appears from comparing the arches which the head describes when moving on the neck, or the loins when moving on the pelvis.

The *lumbar vertebrae* as they descend, have their oblique processes at a greater distance from each other, and facing more backwards and forwards.

Both transverse and spinal processes of the middlemost *vertebrae* of the loins are longest and thickest; in the *vertebrae* above and below they are less: So that these processes of the first and

*Nervus, renalis.*

and fifth \* are the least, to prevent their striking on the ribs or *ossâ ilium*, or their bruising the muscles in the motions of the spine.

The *epiphyses* round the edges of the bodies of the *lumbar vertebrae* are most raised in the two lowest, which consequently make them appear hollower in the middle than the others are.

The body of the fifth *vertebra* is rather thinner than that of the fourth.—The spinous process of this fifth is smaller, and the oblique processes face more backwards and forwards than in any other *lumbar vertebra*.

After considering the structure of the particular *vertebrae*, and their mutual connection, we may observe a solicitous care taken that they shall not be disjoined, but with great difficulty for besides being connected by strong ligaments proportioned to the forces which are to be resisted, their bodies either enter so into each other, as to prevent their being displaced any way, as in the *vertebrae* of the neck; or they are proped on all sides, as these of the back are by the ribs; or their surfaces of contact are so broad, as to render the separation most impracticable, as in the *loins*; while the depth and articulation of the oblique processes are exactly proportioned to the quantity of motion which the other parts of the bones allow, or the muscles can perform: Yet, these oblique processes are small, and therefore not capable of so secure a conjunction as the larger bodies, they may sooner yield to a disjoining force; but then their dislocation

\* Ασχαλίτης, fulciens.



not of near so bad consequence as the separation of the bodies would be. For, by the oblique processes being dislocated, the muscles, ligaments, and *spinal* marrow are indeed stretched; but this marrow must be compressed, and entirely destroyed, when the body of the *vertebra* is removed out of its place.

The *FALSE VERTEBRÆ* compose the under pyramid of the *spine*. They are distinguished from the bones already described sufficiently enough by this epithet of *false*; because each bone into which they can be divided in young people, resembles the *true vertebrae* in figure, yet none of them contribute to the motion of the trunk of the body; they being immovably united to each other in adults, except at their lower part, where they are moveable; whence they are commonly divided into two bones, *os sacrum*, and *coccygis*.

*OS SACRUM* \*, is so called, from being offered in sacrifice by the ancients, or rather because of its largeness in respect of the other *vertebrae*.—This bone is of an irregular triangular shape, broad above, narrow below, convex before, and behind, for the advantageous origin of the muscles that move the *spine* and thigh backwards; and concave behind, for enlarging the cavity of the *pelvis*.—Four transverse lines of a colour different from the rest of the bone which are seen on its fore-part, are the marks of the division of the five different bones of which it consists in young persons.

The

\* *ἱερὸν, σπονδυλὸς μέγας* Hippocrat. *ὀσπασπονδυλόν, οὐρί-πλατυν*, *latum, os clivium, clavium*.

The fore-part of the *os sacrum*, analogous to the bodies of the *true vertebra*, is smooth and flat, to allow a larger space for the contained bowels, without any danger of hurting them; or this flat figure may be owing to the equal pressure of these bowels, particularly of the large gut.——The back-part of it is almost straight without so large a cavity as the *vertebra* have, because the spinal marrow, now separated in the *cauda equina*, is small.——The bridges between the bodies and processes of this bone, are much thicker, and in proportion shorter, than in the former class of bones.——The strength of these cross bridges is very remarkable in the three upper bones, and is well proportioned to the incumbent weight of the trunk of the body, which these bridges sustain in a transverse consequently an unfavourable, situation, while the body is erect.

There are only two oblique processes of the *os sacrum*; one standing out on each side from the upper part of the first bone.——Their plane erect surfaces face backwards, and are articulated with the inferior oblique processes of the last *vertebra* of the loins, to which each of these processes is connected by a strong ligament, which rises from a scabrous cartilage round their roots, where mucilaginous glands are also lodged.—Instead of the other oblique processes of this bone, four rough tubercles are to be seen on each side of its surface behind, from which the *musculus sacer* has its origin.

The transverse processes here are all grouped together into one large strong oblong process.

each side; which so far as it answers to the  
 of three bones, is very thick, and divided  
 into two irregular cavities, by a long perpendi-  
 cular ridge.—The foremost of the two ca-  
 vities has commonly a thin cartilaginous skin  
 covering it in the recent subject, and is adapt-  
 ed to the unequal protuberance of the *os ilium*,  
 and a strong ligament connects the circum-  
 ference of these surfaces of the two bones.—  
 The cavity behind is divided by a transverse ridge  
 into two, where strong ligamentous strings that  
 pass from this bone to the *os ilium* with a cellu-  
 lar substance containing *mucus*, are lodged.

The transverse processes of the two last bones  
 of the *os sacrum* are much smaller than the  
 former.—At their back-part near their edge,  
 a small and oblong flat surface give rise to two  
 strong ligaments which are extended to the *os*  
*ilium*; and are therefore called *sacrosciatic*.

The spinal processes of the three uppermost  
 of the *os sacrum* appear short, sharp, and  
 most erect, while the two lower ones are  
 bent behind; and sometimes a little knob is to  
 be seen on the fourth, though generally it is  
 indicated, without the two legs meeting in-  
 to the spine; in which condition also the first is  
 to be seen; and sometimes none of them  
 are, but leave a *sinus*, or rather *fossa*, in-  
 stead of a canal (*a*).—The *musculus latissimus*  
*angustissimus dorsi*, *sacro-lumbalis*, and *glutaeus*  
*mus*, have part of their origins from these  
 processes.

The

The canal between the bodies and process of this bone, for the *cauda equina*, is triangular; and becomes smaller as it descends, as the *cauda* also does.—Below the third bone, the passage is no more a complete bony canal, but is open behind; and is only there defended by a strong ligamentous membrane stretched over it, which, with the muscles that cover it, are very prominent on each side, is a sufficient defence for the bundle of nerves within.

At the root of each oblique process of the bone, the notch is conspicuous, by which, and such another in the last *vertebra* of the loins, a passage is left for the twenty-fourth pair of spinal nerve; and, in viewing the *os sacrum*, either before or behind, four large holes appear on each side, in much the same height, as were the marks of the union of its several bones in the main. Some of the largest nerves of the body pass through the anterior holes; and superior grooves running outwards from them in different directions, shew the course of the nerves.—From the intervals of these grooves the *pyriformis* muscle chiefly rises.—The holes in the back-part of the bone are covered by membranes which allow small nerves to pass through them.—The two uppermost of these holes, especially on the fore-side, are the largest; and as the bone descends, they gradually turn smaller. Sometimes a notch is only formed at the lower part in each side of this bone, and in other subjects there is a hole common to it and the *os coccygis*, through which the twenty-ninth pair of spinal nerves passes; and frequently a bony bridge is formed on the

part of each side by a process sent up from the back-part of the *os coccygis*, and joined to the knobs which the last bone of the *os sacrum* has instead of a spinal process. Under this edge or *jugum*, the twenty-ninth pair of spinal nerves runs in its course to the common plexus just now described.

The upper part of the body of the first bone resembles the *vertebrae* of the loins; but the last fifth bone is oblong transversely, and hollow in the middle of its lower surface.

The substance of the *os sacrum* is very spongy, without any considerable solid external plates, and is lighter proportionally to its bulk than any other bone in the body; but is secured from injuries by the thick muscles that cover it behind, and by the strong ligamentous membranes that closely adhere to it.—As this is one of the most remarkable instances of this kind of defence afforded a soft weak bone, we may make the general observation, That, wherever we meet with such a bone, one or the other, or both these defences are made use of; the first to ward off injuries, and the second to keep the substance of the bone from yielding too easily.

This bone is articulated above to the last *vertebra* of the loins, in the manner that the *vertebrae* are joined; and therefore the same motions may be performed here.—The articulation of the lower part of the *os sacrum* to the *os coccygis* seems well enough adapted for allowing considerable motion to the last bone, was it not much confined by ligaments. Laterally, the *os sacrum* is joined



to the *ossa ilium* by an immoveable *synchondrosis*, or what almost deserves the name of future: for the cartilaginous crust on the surface of the bones is very thin, and both the surfaces are so scabrous and unequal, as to be indented into each other; which makes such a strong connection, that great force is required to separate them, after all the muscles and ligaments are cut.—Frequently the two bones grow together in old subjects.

The uses of the *os sacrum* are, to serve as the common base and support of the trunk of the body, to guard the nerves proceeding from the end of the spinal marrow, to defend the back-part of the *pelvis*, and to afford sufficient origin to the muscles which move the trunk and thigh.

The bones that compose the *os sacrum* of infants, have their bodies separated from each other by a thick cartilage; and, in the same manner as the *true vertebrae*, each of them consists of a body and two lateral plates, connected together by cartilages; the ends of the plates seldom being contiguous behind.

*OS COCCYGIS* \*, or rump bone, is that angular chain of bones depending from the *os sacrum*; each bone becoming smaller as they descend, till the last ends almost in a point. The *os coccygis* is convex behind, and concave before; from which crooked pyramidal figure, which was thought to resemble a cock's beak, it has got its name.

\* *ὀππορυγιον*, *ὀπίσθεν*, caudæ os, *spondylium*, os coccygis.

This bone consists of four pieces in people of middle age :——In children, very near the whole of it is cartilage : In old subjects, all the pieces are united, and become frequently one continued bone with the *os sacrum*.

The highest of the four bones is the largest, with shoulders extended farther to each side at the end of the *os sacrum* ; which enlargements should, in my opinion, serve as a distinguishing mark to fix the limits of either bone ; therefore should take away all dispute about reckoning the number of bones, of which each or other of these two parts of the *false vertebrae*, is composed ; which dispute must be kept up, so long as the numbering five or six bones in the *os sacrum* depends upon the certain accident of this broad shouldered little bone being united to or separated from it.——

The upper surface of this bone is a little hollow.——From the back of that bulbous part and its *shoulders*, a process often rises up on each side, to join with the bifurcated spine of the fourth and fifth bones of the *os sacrum*, to form the bony bridge mentioned in the description of the *os sacrum*.——Sometimes these shoulders are joined to the sides of the fifth bone of the *os sacrum*, to form the hole in the middle of the side common to these two bones, for the passage of the twenty-ninth pair of spinal nerves.——Immediately below the shoulders of the *os coccygis*, a notch may be remarked in the middle of the side, where the thirtieth pair of the spinal nerves passes.——The lower end of this bone is formed into a small head, which very often is hollow in the middle.

The three lower bones gradually become smaller, and are spongy; but are strengthened by a strong ligament which covers and connects them. — Their ends, by which they are articulated, are formed in the same manner as those of the first bone are.

Between each of these four bones of young subjects a cartilage is interposed; therefore their articulation is analogous to that of the bodies of the *vertebræ* of the neck: For, as has been above remarked, the lower end of the *os sacrum*, and of each of the three superior bones of the *os coccygis*, has a small depression in the middle; and the upper part of all the bones of the *os coccygis* is a little concave, and consequently the interposed cartilages are thickest in the middle, to fill up both cavities; which they connect the bones more firmly. When the cartilages ossify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above. — From this sort of articulation, it is evident, that, unless these bones grow together, all of them are capable of motion; of which, the first and second, especially this last, enjoys the largest share.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is suspended.

To the sides of these bones of the *os coccygis*, the *coccygæi* muscles (*a*), and part of the *levator ani*, and of the *glutæi maximi*, are fixed.

(*a*) Douglas, Myograph. chap. 40. — Eustach. tab. No. 45. 29.

The substance of these bones is very spongy, and in children cartilaginous; there being only part of the first bone ossified in a new-born infant.—Since therefore the *intestinum rectum* in children is not so firmly supported as it is in adults, this may be one reason why they are more subject to a *proidentia ani* than old people (a).

From the description of this bone, we see how little it resembles the *vertebrae*; since it seldom has processes, never has any cavity for the spinal marrow, nor holes for the passage of nerves.—Its connection hinders it to be moved either side; and its motion backwards and forwards is much confined: Yet, as its ligaments can be stretched by a considerable force, this is a great advantage in the excretion of the *feces alvine*, and much more in child-bearing, that this bone should remain moveable; and the right management of it, in debility of women, may be of great benefit to them (b).—The mobility of the *os coccygis* diminishes as people advance in age, especially when its ligaments and cartilages have not been kept flexible by being stretched, is probably one reason why the women, who were old maids before they marry, have generally hard labour in child-bed.

The *os coccygis* serves to sustain the *intestinum rectum*; and, in order to perform this office more effectually, it is made to turn with a

R 3

curve

(a) Spigel. de humani corp. fabric. lib. 2. cap. 22. —

(b) De offib. par. 2. cap. 3.

(c) Paaw, ibid. — Deventer, Operat. chirurg. cap. 27.

curve forewards; by which also the bone itself as well as the muscles and teguments, is preserved from any injury, when we sit with our body reclined back.

The second part of the trunk of the skeleton, the *PELVIS*, is the cylindrical cavity at the lower part of the *abdomen*, formed by the *os sacrum*, *os coccygis*, and *ossa innominata* which last therefore fall now in course to be examined.

Though the name of *OSSA INNOMINATA*\* contributes nothing to the knowledge of their situation, structure, or office, yet they have been so long and universally known by it, that there is no occasion for changing it.—They are two large broad bones which form the fore-part and sides of the *pelvis*, and the lower part of the sides of the *abdomen*—In children each of these bones is evidently divided into three; which are afterwards so intimately united, that scarce the least mark of their former separation remains: Though notwithstanding, they are described as containing each of three bones, to wit, the *os ilium*, *ischium*, and *pubis*; which I shall first describe separately, and then shall consider what is common to any two of them, or to all the three.

*OS ILIUM*†, or *baunch-bone*, is situated highest of the three, and reaches as far down as one third of the great cavity into which the head of the thigh-bone is received.

\* Σκελετὸν, προσφύσας, sacro conjuncta.

† Λαγόνων, κενίων, scaphium, lumbare, clunium, clunianæ.



The external side of this bone is unequally convex, and is called its *dorsum*; — the internal concave surface is by some (but improperly named) is *costa*. — The semicircular edge is the highest part of this bone, which is tipped with a cartilage in the recent subject, is named the *spine*, into which the external or descending oblique muscle of the *abdomen* is inserted; and from it the internal ascending oblique and the transverse muscles of the belly, the *gluteus maximus*, *quadratus lumborum*, *latissimus dorsi*, have their origin. Some (a) are of opinion, that it is only the tendinous part of all these muscles, and not a cartilage, commonly alledged, that covers this bony edge. — The ends of the spine are more prominent than the surface of the bone below; therefore are reckoned processes. — In the anterior spinal process, the *sartorius fascialis* muscles have their rise, and the other end of the doubled tendon of the external oblique muscle of the *abdomen*, commonly called *Fallopian's* or *Poupart's* ligament, is fixed to it. — The inside of the posterior spinal process, and of part of the spine forward, is that, is made flat and rough where the *sacrotubularis* and *longissimus dorsi* rise; and to the outside ligaments, extended to the *os sacrum* and transverse processes of the fifth and sixth *vertebrae* of the loins, are fixed (b). — On the anterior spinal process another protuberance.

Winslow, Exposition anatomique du corps humain, des os frais, § 96.

Weidbrecht, Syndesmolog. sect. 4. § 39. 40. 46. 47.

tubérance stands out, which, by its situation may be distinguished from the former, by adding the epithet of *inferior*, where the *musculus rectus tibiae* has its origin (a).—Between these two anterior processes the bone is hollowed where the beginning of the *sartorius* muscle is lodged.—Below the posterior spinal process, a second protuberance of the edge of the bone is in like manner observable, which is closely applied to the *os sacrum*.—Under the last process a considerable large niche is observable in the *os ilium*; between the sides of which and the strong ligament that is stretched over from the *os sacrum* to the sharp-pointed process of the *os ischium* of the recent subject a large hole is formed, through which the *musculus pyriformis*, the great sciatic nerve, the posterior crural vessels pass, and are protected from compression.

The external broad side or *dorsum* of the *os ilium* is a little hollow towards the front part; farther back it is as much raised; the surface is considerably concave; and, lastly, it is uneven. These inequalities are occasioned by the actions of the muscles that are situated on its surface.—From behind the uppermost of the two anterior spinal processes, in such bones as are strongly marked by the muscles, a circular ridge is extended to the hollowed surface of the sciatic nerve. Between this ridge and this ridge, the *glutæus medius* takes its rise. Immediately from above the lower end of the anterior spinal processes, a second

(a) Baker, *Curs. osteolog. demonstr.* 3.

stretched to the niche. Between this and the former ridge, the *glutaeus minimus* has its origin.—On the outside of the posterior spinous processes, the *dorsum* of the *os ilium* is hard and rough, where part of the *musculus glutaeus maximus* and *pyriformis* rises.—The thickest part of this bone is the thickest, and is formed into a large cavity with high brims, which assist in composing the great *acetabulum*; which shall be considered, after all the three bones that constitute the *os innominatum* are described.

The internal surface of the *os ilium* is concave in its broadest fore-part, where the internal iliac muscle has its origin, and some part of the *intestinum ilium* and *colon* is lodged.—From this large hollow, a small sinuous cavity is continued obliquely forewards, at the insertion of the anterior inferior spinal process, where the *psoas* and *iliacus* muscles, with the arterial vessels and nerves, pass.—The large cavity is bounded below by a sharp ridge, which runs from behind forewards; and, being continued with such another ridge of the *os ischium*, forms a line of partition between the *crura* and *pelvis*.—Into this ridge the tendon of the *psoas parvus* is inserted.

All the internal surface of the *os ilium*, beneath this ridge, is very unequal: For the upper part is flat, but spongy, where the *sacrospinatus* and *longissimus dorsi* rise.—Lower down, there is a transverse ridge from which the foramina go out to the *os sacrum*.—Immediately below this ridge, the rough unequal cavities,

vities and prominences are placed, which are exactly adapted to those described on the surface of the *os sacrum*.—In the same manner, the upper part of this rough surface is porous, for the firmer adhesion of the ligamentous cellular substance; while the lower part is more solid and covered with a thin cartilaginous skin, for its immoveable articulation with the *os sacrum*.—From all the circumference of this large unequal surface, ligaments are extended to the *os sacrum*, to secure more firmly the conjunction of these bones.

The passages of the medullary vessels are very conspicuous, both in the *dorsum* and crest of many *ossa ilium*; but in others they are not considerable.

The posterior and lower parts of these bones are thick; but they are generally exceeding thin and compact at their middle, where they are exposed to the actions of the *musculi glutei* and *iliacus internus*, and to the pressure of the bowels contained in the belly.—The substance of the *ossa ilium* is mostly cellular, except a thin external table.

In a ripe child, the spine of the *os ilium* is cartilaginous, and is afterwards joined to the bone in form of an *epiphyse*.—The lower end of this bone is not completely ossified.

*OS ISCHIIUM*\* or *hip-bone*, is of a middle bulk between the two other parts of the *os innominatum*, is situated lowest of the three, and is of a very irregular figure.—Its

\* *Coxæ, coxendicis, pixisæ.*

might be marked by an horizontal line drawn near through the middle of the *acetabulum*; for the upper bulbous part of this bone forms some less than the lower half of that great cavity, and the small leg of it rises to reach the same height on the other side of the great hole common to this bone and the *os ischi-*

From the upper thick part of the *os ischi-*, a sharp process, called by some *spinous*, stands backwards, from which chiefly the *musculus coccygaeus* and *superior gemellus*, and part of the *levator ani*, rise; and the anterior or external *sacrosciatic* ligament is fixed to it.—Between the upper part of this ligament and the bones, it was formerly observed that the *gluteus form* muscle, the posterior crural vessels, the sciatic nerve, pass out of the *pelvis*.—Immediately below this process, a sinuosity is formed for the tendon of the *musculus obturator internus*.—In a recent subject, this part of the bone, which serves as a pulley on which the *obturator* muscle plays, is covered with a prominent cartilage, that, by two or three small ridges, points out the interstices of the vessels in the tendon of this muscle.——The anterior surface of the bone at the root of this bulbous process is made hollow by the *pyriformis* or *iliacus externus* muscle.

Below the sinuosity for the *obturator* muscle, is the great knob or *tuberosity*, covered with cartilage or tendon (*a*).——The lower part of the tuberosity gives rise to the inferior



inferior *gemellus* muscle. ——— To a ridge the inside of this, the external or posterior *sacrosciatic* ligament is so fixed that between it, the internal ligament, and the sinuosity the *os ischium*, a passage is left for the internal *obturator* muscle. ——— The upper the smooth part of the *tuber*, called by some *dorsum*, has two oblique impressions on it. The inner one gives origin to the long head of the *biceps flexor tibiae* and *seminervus* muscles, and the *semimembranosus* rises from the exterior one, which reaches higher and nearer the *acetabulum* than the other. ——— The lower, thinner, more scabrous part of the *tuber* which bends forwards, is also marked with two flat surfaces, whereof the internal is what the *os ischium* lean upon in sitting, and the external gives rise to the largest head of the *triceps adductor femoris*. ——— Between the external margin of the tuberosity and the great hole of the *innominatum*, there is frequently an oblique ridge extended down from the *acetabulum* which gives origin to the *quadratus femoris*. ——— As the *tuber* advances forwards, it becomes smaller, and is rough, for the origin of the *musculus transversalis* and *erector penis*. ——— The small leg of it, which mounts upwards to join the *os pubis*, is rough and prominent at its edge, where the two lower heads of the *triceps* or *quadriceps adductor femoris* take their rise.

The upper and back part of the *os ischium* is broad and thick; but its lower and anterior part is narrower and thinner. ——— Its substance is of the structure common to broad bones.

The *os ilium* and *pubis* of the same side are the only bones which are contiguous to the *ischium*.

The part of the *os ischium* which forms the *acetabulum*, the spinous process, the great *tuber*, and the recurved leg, are all cartilaginous at birth.——The *tuber*, with part of the leg or process above it, becomes an epiphysse before the bone is fully formed.

The *OS PUBIS\**, or *share bone*, is the least of the three parts of the *os innominatum*, and is placed at the upper fore-part of it.——The thick largest part of this bone is employed in forming the *acetabulum*; from which coming much smaller, it is stretched inwards to its fellow of the other side, where again it grows larger, and sends a small branch downwards to join the end of the small leg of the *ischium*.——The upper fore-part of each *pubis* is tuberos and rough where the *musculus rectus* and *pyramidalis* are inserted.

From this a ridge is extended along the outer edge of the bone, in a continued line with such another of the *os ilium*, which divides the *abdomen* and *pelvis*. The ligament *Fallopian* is fixed to the internal end of this ridge, and the smooth hollow below it is crossed by the *psoas* and *iliacus internus* muscles along with the anterior crural vessels and nerves behind the ligament.——Some way below the former ridge, another is extended from the tuberos part of the *os pubis* downwards and outwards towards the *acetabulum*;  
S between

*scrotum, pectinis, penis, pudibundum, fenestratum.*

between these two ridges the bone is hollow and smooth, for lodging the head of the *pectineus* muscle.——Immediately below, where the lower ridge is to take the turn downwards, a winding notch is made, which is comprehended in the great *foramen* of a skeleton, but is formed into a hole by a subtended ligament in the recent subject, for the passage of the posterior crural nerve, an artery and a vein.——The internal end of the *pubis* is rough and unequal, for the firm adhesion of the thick ligamentous cartilage that connects it to its fellow of the other side.——The process which goes down from the *pubis* to the *os ischium* is broad and rough before, where the *gracilis* and upper heads of the *adductor*, or rather *quadriceps adductor femoris*, have their origin.

The substance of the *os pubis* is the same as of other broad bones.

Only a part of the large end of this bone is ossified, and the whole leg is cartilaginous in a child born at the full time.

Betwixt the *os ischium* and *pubis* a very large irregular hole is left, which, from its resemblance to a door or shield, has been called *thyroides*. This hole is all, except a small notch for the posterior crural nerve, filled in a recent subject with a strong ligamentous membrane, that adheres very firmly to its circumference. From this membrane chiefly two *obturator* muscles, external and internal, take their rise.——The great design of this hole, besides rendering the bone lighter, is to allow a strong enough origin to the *obturator*

muscles, and sufficient space for lodging their bellies, that there may be no danger of disturbing the functions of the contained viscera of the *pelvis* by the actions of the internal, nor of the external being bruised by the thigh bone, especially by its lesser *trochanter*, in the motions of the thigh inwards: with which inconveniences must have happened, had the *ossa innominata* been compleat here, and of sufficient thickness and strength to serve as the fixed point of these muscles.—The bowels sometimes make their way through the notch for the vessels, at the upper part of the *thyroid* hole, and this causes a *hernia* in this place (a).

On the external surface of the *ossa innominata*, near the outside of the great hole, a large deep cavity is formed by all the three bones conjointly: For the *os pubis* constitutes about the fifth; the *os ilium* makes something more than two fifths, and the *os ischium* as much more than two fifths. The brims of the cavity are very high, and are still much more enlarged by the ligamentous cartilage, in which they are tipped in a recent subject. From this form of the cavity it has been called *acetabulum*; and for a distinguishing character, the name of the bone that constitutes the largest share of it is added; therefore *acetabulum ossis ischii* \* is the name this cavity commonly bears.—Round the base

S 2

of

Memoires de l'acad de chirurgie, tom. 1, p. 709. &c.

Coxæ, coxendicis.

of the *supercilia* the bone is rough and unequal where the *capsular* ligament of the articulation is fixed.——The brims at the upper and back part of the *acetabulum* are much larger and higher than any where else; which is very necessary to prevent the head of the femur from slipping out of its cavity at this place where the whole weight of the body bears upon it, and consequently would otherwise be constantly in danger of thrusting it out.

——As these brims are extended downwards and forwards, they become less; and at the internal lower part a breach is made in them from the one side of which to the other, the ligament is placed in the recent subject; under which a large hole is left, which contains a fatty cellular substance and vessels. The reason of which appearance has afforded much matter of debate. To me it seems evidently contrived for allowing a larger motion to the thigh inwards: For if the bony brim had been here continued, the neck of the thigh bone must have struck upon them when the thighs were brought across each other, which, in a large strong motion this would have endangered the neck of the bone, or brim of the other. Then the vessels which are distributed to the joint may easily enter at the sinuosity in the bottom of the breach; which being however larger than necessary for that purpose, allows the large cartilaginous gland of the joint to escape beneath the ligament, when the head of the thigh bone is in hazard of pressing too much upon it in motion.



otions of the thigh outwards (a).— Besides the difference in the height of the brims, the *acetabulum* is otherwise unequal: For the lower external part of it is depressed below the cartilaginous surface of the upper-part, and is not covered with cartilage; into the upper-part of this particular depression, where it is deepest and of a semilunar form, the ligament of the thigh-bone, commonly, though improperly, called the *round* one, is inserted; while in its more superficial lower part the large mucilaginous gland of this joint is lodged. The larger share of this separate depression is formed by the *os ischium*.

From what has been said of the condition of the three bones composing this *acetabulum* in new-born children, it must be evident, that a considerable part of this cavity is cartilaginous in them.

The *ossa innominata* are joined at their back to each side of the *os sacrum* by a sort of suture, with a very thin intervening cartilage, which serves as so much glue to cement these bones together; and strong ligaments go from the circumference of this unequal surface, to connect them more firmly. The *ossa innominata* are connected together at their fore-part by the fibrous cartilage interposed between the *ossa pubis*.—These bones can therefore have no motion in a natural state, except what is common to the trunk of the body, or to the *os sacrum*. But it has been disputed; whether or not they loosen so much from each other, from the *os sacrum*, in child-birth, by the

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flow.

flow of *mucus* to the *pelvis*, and by the throw of the labour, as that the *ossa pubis* recede from each other, and thereby allow the passage between the bones to be enlarged.—Several observations (*a*) shew that this relaxation sometimes happens: But those who had frequent opportunities of dissecting the bodies of women who died immediately after being delivered of children, teach us to beware of regarding this as the common effect of child-birth; for they have found such a relaxation in very few of the bodies which they examined (*b*).

Considering what great weight is supported in our erect posture, by the articulation of the *ossa innominata* with the *os sacrum*, there is great reason to think that if the congruent surfaces of these bones were once separated (without which, the *ossa pubis* cannot shuffle against each other), the ligaments would be violently stretched, if not torn; from whence many disorders would arise (*c*).

Each *os innominatum* affords a socket (*acetabulum*) for the thigh-bones to move in, and the trunk of the body rolls here so much upon the heads of the thigh-bones, as to allow the most conspicuous motions of the *trunk*, which are commonly thought to be performed by the bones of the spine.—This articulation

(*a*) Bauhin. Theat. anat. lib. 1. cap. 49.—Spigel. lib. 2. cap. 24.—Riolan. Anthropogr. lib. 6. cap. 12.—Diemerbroeck, Anat. lib. 9. cap. 16.

(*b*) Hildan. Epist. cent. obs. 46.—Dionis. Sixième monst. des os.—Morgagn. Advers. 3. animad. 15.

(*c*) Ludov. in Ephem. German. dec. 1, ann. 3. obs. 2.

more fully described after the *ossa femoris* examined.

The *pelvis* then has a large open above where it is continued with the *abdomen*, is strongly fenced by bones on the sides, back, and fore-part, and appears with a wide opening now, in the skeleton; but, in the recent subject, a considerable part of the opening is filled with the *sacrosciatic ligaments*, *pyriform*, *inter-obturator*, *levatoris ani*, *gemini*, and *coccygai* muscles, which support and protect the contained parts better than bones could have done; so the space is only left at the lowest part of for the large excretories, the *vesica urinaria*, *intestinum rectum*, and in females, the *uterus*, to discharge themselves.

The *THORAX* †, or *chest*, which is the upper part of the trunk of the body which we have not yet described, reaches from below the neck to the belly; and, by means of the bones which guard it, is formed into a large cavity: the figure of which is somewhat conoidal; but the upper smaller end is not finished, being left open for the passage of the wind-pipe, gullet, and large blood-vessels; and its lower part, or base, has no bones, and is shorter before than behind; so that, to carry on our comparison, it appears like an oblique section of the conoid. Besides which we ought also to remark, that the upper part of this cavity is narrower than some way

*Pectus, cassum.*

way above (a); and that the middle of the back-part is considerably diminished by the bones standing forwards into it.

The bones which form the *thorax* are the twelve dorsal *vertebræ* behind, the ribs on the sides, and the *sternum* before.

The *vertebræ* have already been described as part of the spine; and therefore are now to be passed.

The *RIBS*, or *costæ* \*, (as if they were *custodes*, or guards, to these principal organs of the animal machine, the heart and lungs) are the long crooked bones placed at the sides of the chest, in an oblique direction downwards in respect of the back bone.——The number is generally twelve on each side; though frequently eleven or thirteen have been found.——Sometimes the ribs are found preternaturally conjoined or divided (c).

The ribs are all concave internally; whereas they are also made smooth by the action of the contained parts, which, on this account, are in no danger of being hurt by them; and they are convex externally, that they might resist that part of the pressure of the atmosphere which is not balanced by the air within the lungs, during *inspiration*.——The ends of the ribs next the *vertebræ* are rounder than they are after these bones have advanced forwards when they become flatter and broader, and have

(a) Albin. de ossib. § 169.

\* Πλευραι, περιεῖρνα, σπαδαί.

(b) Riolan. Comment. de ossibus, cap. 19.—Marchetti. cap. Cowper Explicat. tab. 93. and 94.—Morgagn. Advers.

(c) Sue Trad. d'osteolog. p. 141.

upper and lower edge, each of which is made  
 rough by the action of the *intercostal* muscles,  
 inserted into them. These muscles, being all  
 nearly equal force, and equally stretched in  
 the interstices of the ribs, prevent the broken  
 ends of these bones in a fracture from being  
 moved far out of their natural place, to in-  
 terrupt the motion of the vital organs.—The  
 upper edge of the ribs is more obtuse and  
 tender than the lower, which is depressed on  
 its internal side by a long *fossa*, for lodging  
 the intercostal vessels and nerves; on each  
 of which there is a ridge, to which  
 the intercostal muscles are fixed. The *fossæ*  
 is not observable however at either end of  
 the ribs; for at the posterior or root, the  
 vessels have not yet reached the ribs; and, at  
 the fore-end, they are split away into branches,  
 to serve the parts between the ribs: Which  
 only teaches surgeons one reason of the  
 greater safety of performing the operation of  
*empyema* towards the sides of the *thorax*,  
 either near the back or the breast.

At the posterior end \* of each *rib*, a little  
 process is formed, which is divided by a middle  
 line into two plain or hollow surfaces; the  
 first of which is the broadest and deepest in  
 all of them. The two plains are joined to  
 the bodies of two different *vertebræ*, and the  
 process forces itself into the intervening carti-  
 lage.—A little way from this head, we find,  
 on the external surface, a small cavity, where  
 mucilaginous glands are lodged; and round the  
 neck, the bone appears spongy, where the cap-  
 sular

*capitulum, remulus.*



ular ligament of the articulation is fixed.—Immediately beyond this a flattened tubercle rises with a small cavity at, and roughness about the root, for the articulation of the rib with the transverse process of the lowest of the two *vertebrae*, with the bodies of which the head of the rib is joined.—Advancing further on the external surface, we observe in most of the ribs another smaller tubercle, into which ligaments which connect the ribs to each other and to the transverse processes of the *vertebrae* and portions of the *longissimus dorsi*, are inserted.—Beyond this the ribs are made flat by the *sacro-lumbalis* muscle, which is inserted into the part of this flat surface farthest from the spine, where each rib makes a considerable curve, called by some its *angle*.—Then the rib begins to turn broad, and continues so to its anterior end \*, which is hollow and spongy, for the reception of, and firm coalition with the cartilage that runs thence to be inserted into the *sternum*, or to be joined with some other cartilage.—In adults, generally the cavity at the end of the ribs is smooth and polished on the surface; by which the articulation of the cartilage with it has the appearance of being designed for motion; but it has none.

The substance of the ribs is spongy, cellular, and only covered with a very thin external mottled surface, which increases in thickness and strength as it approaches the *vertebrae*.

To the fore-end of each rib a long broad and strong cartilage is fixed, and reaches the

† Πλατὺν, palmula.

the *sternum*, or is joined to the cartilage of the next rib. This course, however, is not in a straight line with the rib; for generally the cartilages make a considerable curve, the convex part of which is upwards; therefore, at their insertion into the *sternum*, they make an obtuse angle above, and an acute one below.—These cartilages are of such a length as never allow the ribs to come to a right angle with the spine; but they keep them situated so obliquely, as to make an angle very considerably obtuse above, till a force exceeding the elasticity of the cartilages is applied.—These cartilages, as all others, are firmer and harder internally, than they are on their external surface; and sometimes, in old people, all their middle substance becomes bony, while a thin cartilaginous *lamella* appears externally (*a*). Ossification however begins frequently at the external surface.—The greatest alternations of the cartilages being made at their greatest curvature, that part remains frequently cartilaginous, after all the rest is ossified (*b*).

The ribs then are articulated at each end, in which the one behind is doubly joined to the *vertebra*; for the head is received into the cavities of two bodies of the *vertebra*, and the other tubercle is received into the depression of the transverse process of the lower *vertebra*.

—When one examines the double articulation, he must immediately see, that no other motion can here be allowed than upwards and downwards; since the transverse process hinders the

Vesal. lib. 2. cap. 19.

Havers. Osteolog. nov. disc. 5. p. 289.

the rib to be thrust back ; the resistance on the other side of the *sternum* prevents the ribs coming foreward ; and each of the joints, with the other parts attached, opposes its turning round. But then it is likewise evident, that even the motion upwards and downwards can be but small in any one rib at the articulation itself. But as the ribs advance forewards, the distance from their center of motion increasing, the motion must be large, and it would be very conspicuous at their anterior ends, were not they resisted there by the cartilages, which yield so little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occasions the twist remarkable in the ribs at the place near their fore-end where they are most resisted (a).

Hitherto I have laid down the structure and connection which most of the ribs enjoy, belonging to all of them ; but must now consider the specialities wherein any of them differ from the general description given, or from each other.

In viewing the ribs from above downwards their figure is still straighter ; the upper being the most crooked of any.—Their obliquity in respect of the spine increases as they descend ; so that though their distances from each other is very little different at their back, yet at their fore-ends the distances between the lower ones must increase.—In consequence too of this increased obliquity of the lower

(a) Winslow. Memoires de l'acad. des sciences, 1720

ch of their cartilages makes a greater curve its progress from the rib towards the *sternum*; and the tubercles, that are articulated to the transverse processes of the *vertebrae*, have their smooth surfaces gradually facing more upwards.——The ribs becoming thus more oblique, while the *sternum* advances forwards in descent, makes the distance between the *sternum* and the anterior end of the lower ribs greater than between the *sternum* and the ribs above; consequently the cartilages of those that are joined to the breast-bone are longer in the lower than in the higher ones.——These cartilages are placed nearer to each other as the ribs descend, which occasions the curvature of the cartilages to be greater.

The length of the ribs increases from the first and uppermost rib, as far down as the ninth; and from that to the twelfth, as gradually diminishes.——The superior of the two, or rather hollow surfaces, by which the ribs are articulated to the bodies of the *vertebrae*, gradually increases from the first to the ninth rib, and is diminished after that in each rib.——The distance of their angles from the heads always increases as they descend to the ninth, because of the greater breadth of the *sacro-lumbalis* muscle (a).

The ribs are commonly divided into *true* and *false*.

The *true* + *costae* are the seven upper ones on each side, whose cartilages are all gradually

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dually

Winslow. Exposition anatomique des os secs, § 643.

Winn, Germān, legitim.

dually longer as the ribs descend, and are joined to the breast-bone; so that being pressed constantly between two bones, they are flattened at both ends, and are thicker, harder, and more liable to ossify, than the other cartilages, they are not subject to so much pressure. These ribs include the heart and lungs; and therefore are the proper or true *custodes* of life.

The five inferior ribs of each side are *false* or *BASTARD*\*, whose cartilages do not reach to the *sternum*; and therefore, wanting the resistance at their fore-part, they are there pointed; and, on this account, receiving less pressure, their substance is softer.

————The cartilages of these *false ribs* are shorter as the ribs descend.————To all the five ribs the circular edge of the *diaphragm* is connected; and its fibres, instead of being stretched immediately transversely, and running perpendicular to the ribs, are pressed so as to be often, especially in expiration, parallel to the plane in which the ribs lie. Nay, one may judge by the attachments of these fibres have so frequently to the sides of the *thorax*, a considerable way above where their extremities are inserted into the ribs, and by the situation of the *viscera*, the ways to be observed in a dead subject laid open, that there is constantly a large concavity formed on each side by the *diaphragm* within these bastard ribs, in which the stomach, liver, spleen, &c. are contained; which, being reckoned

† Μαλθακαί, χονδροειδείς, ἀκανθαί, κλίβες, ῥόαι, adulterae, spuriae, illegitimae.



reckoned among the *viscera naturalia*, have occasioned the name of *bastard custodes* to these bones.

Hence in simple fractures of the false ribs, without fever, the stomach ought to be kept moderately filled with food, lest the pendulous ribs falling inwards, should thereby increase the pain, cough, &c. (a).—Hence likewise we may learn how to judge better of the seat of several diseases, and to do the operation of *empyema*, and some others, with more safety than we can do, if we follow the common directions.

The eight upper ribs were formerly (b) classified into pairs, with particular names to each, to wit, the *crooked*, the *solid*, the *pectoral*, the *twisted*: But these names are of so little use, that they are now generally neglected.

The *first* rib of each side is so situated, that the flat sides are above and below, while the edge is placed inwards, and the other outwards, or nearly so; therefore sufficient space is left above it for the subclavian vessels and artery; and the broad concave surface is opposed to the lungs: But then, in consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.—The head of this rib is not divided into two plain surfaces by

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a

Hippocrat. de articulo, § 51. — Pare, lib. 15. cap. 11.

Laurent. Hist. anat. lib. 2. cap. 29. — Paaw, de anat. pert. 3. cap. 2.

a middle ridge, because it is only articulated with the first *vertebra* of the *thorax*.—— Its cartilage is ossified in adults, and is united to the *sternum* at right angles.—— Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the *scalenus* muscle rises.—— Farther forward it is flattened, or sometimes depressed by the clavicle.

The fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs, have their cartilages at least contiguous; and frequently they are joined to each other by costal cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former and to each other by ligaments.

The *eleventh*, and sometimes the *tenth*, has no tubercle for its articulation with the transverse process of the *vertebra*, to which it is only loosely fixed by ligaments.—— The *fossa* in its lower edge is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs.—— Its fore-end is smaller than its body, and its small cartilage is but loosely connected to the cartilage of the rib above.

The *twelfth* rib is the shortest and straightest.—— Its head is only articulated with the last *vertebra* of the *thorax*; therefore it is divided into two surfaces.—— This rib is joined to the transverse process of the *vertebra*, and therefore has no tubercle, being

is pulled necessarily inwards by the diaphragm, which an articulation with the transverse process would not have allowed. — The *fossa* is not found at its under edge, because the vessels run below it. — The fore-part of this is smaller than its middle, and has only a very small-pointed cartilage fixed to it. — To its whole internal side the diaphragm is connected.

The motions and uses of the ribs shall be more particularly treated of, after the description of the *sternum*.

The heads and tubercles of the ribs of a new-born child have cartilages on them; part which becomes afterwards thin epiphyses.

— The bodies of the ribs inchoate gradually after birth upon the cartilages; so that the ribs are proportionally shorter, when compared to the ribs, in adults, than in children.

Here I cannot help remarking the wise providence of our Creator, in preserving us from perishing, as soon as we come into the world. The end of the bones of the limbs remain in a cartilaginous state after birth, and are many years before they are entirely united to the main body of their several bones; where the condyles of the occipital bone, and of the lower jaw, are true original processes, ossified before birth, and the heads and tubercles of the ribs are nearly in the same condition; and therefore the weight of the head is firmly supported; the actions of eating, swallowing, respiration, &c. which are indispensably necessary for us as soon as we

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come.

come into the world, are performed without danger of separating the parts of the bones that are most pressed on in these motions: Whereas, had these processes of the head, jaw, and ribs, been epiphyses at birth, children must have been exposed to danger of dying by such a separation; the immediate consequences of which would be the compression of the beginning of the *spinal* marrow, or want of food, or a stop put to respiration.

The *STERNUM*\*, or *breast-bone*, the broad flat bone, or pile of bones, at the fore-part of the *thorax*.——The number of bones which this should be divided into has occasioned debates among anatomists who have considered it in subjects of different ages.——In adults of a middle age, it is composed of three bones, which easily separate after the cartilages connecting them are destroyed. Frequently the two lower bones are found intimately united; and very often in old people, the *sternum* is a continued bony substance from one end to the other; though we still observe two, sometimes three transverse lines on its surface; which are marks of its former divisions.

When we consider the *sternum* as one bone we find it broadest and thickest above, and becoming smaller as it descends. The internal surface of this bone is somewhat hollowed for enlarging the *thorax*; but the convexity on the external surface is not so conspicuous, because the sides are pressed outwards.

\* *Στήθος*, os pectoris, ensiforme, scutum cordis.

the true ribs; the round heads of whose cartilages are received into seven smooth pits, formed in each side of the *sternum*, and are not firm there by strong ligaments, which on the external surface have a particular radiated texture (*a*).—Frequently the cartilaginous fibres thrust themselves into the bony substance of the *sternum*, and are joined by a sort of suture.—The pits at the upper part of the *sternum* are at the greatest distance one from another, and, as they descend, are nearer; so that the two lowest are contiguous.

The substance of the breast-bone is cellular, with a very thin external plate; especially on its internal surface, where we may frequently observe a cartilaginous crust spread over it (*b*). On both surfaces, however, a strong ligamentous membrane is closely braided; and the cells of this bone are so small, that a considerable quantity of osseous fibres may be employed in the composition of it: hence, with the defence which the muscles afford it, and the moveable support it has from the cartilages, it is sufficiently secured from being broken; for it is strong by its quantity and bony nature; its parts are kept together by ligaments; and it yields enough to elude considerable violence offered (*c*).

So far may be said of this bone in general; and of the three bones, of which, according to the

Ruyfch. Catalog. rar. fig. 9.

Jac. Sylv. in Galen de ossibus, cap. 12.

Senac. in Memoires de l'acad. des sciences. 1724.



the common account, it is composed in adults are each to be examined.

The *first*, all agree, is somewhat of the figure of a heart, as it is commonly painted; only it does not terminate in a sharp point. This is the uppermost thickest part of the *sternum*.

The upper middle-part of this first bone where it is thickest, is hollowed, to make place for the *trachea arteria*; though this cavity is principally formed by the bone being raised on each side of it, partly by the clavicles thrusting it inwards, and partly by the *sterno-mastoid* muscles pulling it upwards.——On the outer side of each tubercle, there is an oblong cavity, that, in viewing it transversely from before backwards, appears a little convex: Into this *glenæ* the ends of the clavicles are received. Immediately below these, the sides of this bone begin to turn thinner; and in each a superficial cavity or a rough surface is to be seen, where the first ribs are received or joined to the *sternum*.——In the side of the under end of the first bone, the half of the pit for the second bone on each side is formed.——The upper part of the surface behind is covered with a strong ligament, which secures the clavicles; and afterwards to be more particularly taken notice of.

The second or middle division of this bone is much longer, narrower, and thinner, than the first; but, excepting that it is a little

\* Σπυγὴ, jugulum; furcula superior.

ver above than below, it is nearly equal all  
 er in its dimensions of breadth or thick-  
 s.—In the sides of it are compleat pits  
 the third, fourth, fifth, and sixth ribs,  
 an half of the pits for the second and se-  
 th. The lines, which are marks of the for-  
 division of this bone, being extended  
 the middle of the pits of one side to the  
 dle of the corresponding pits of the other  
 —Near its middle an unossified part of  
 bone is sometimes found, which, freed  
 the ligamentous membrane or cartilage  
 fills it, is described as a hole; and in  
 place, for the most part, we may observe a  
 verse line, which has made authors divide  
 bone into two.—When the cartilage be-  
 en this and the first bone is not ossified, a  
 ifest motion of this upon the first may be  
 erved in respiration or in raising the *ster-*  
 , by pulling the ribs upwards or distend-  
 the lungs with air in a recent subject.  
 The third bone is much less than the other  
 , and has only one half of the pit for the  
 nth rib formed in it; wherefore it might  
 eckoned only an *appendix* of the *sternum*.  
 In young subjects it is always cartilaginous,  
 is better known by the name of *cartilago xi-*  
*les* or *ensiformis* \*, than any other; though  
 ancients often called the whole *sternum*,  
*sterne*, comparing the two first bones to the  
 handle

Clypealis, gladialis, mucronata, malum granatum, scu-  
 lomachi, epiglottalis, cultralis, medium furculæ inferioris,  
 armis, ensiculata,

handle and this *appendix* to the blade of sword.—This third bone is seldom of the same figure, magnitude, or situation in any two subjects; for sometimes it is a plain triangular bone with one of the angles below, and perpendicular to the middle of the upper side, by which it is connected to the second bone.—In other people the point is turned to one side, obliquely forwards or backwards.—Frequently it is all nearly of an equal breadth, and in several subjects it is bifurcated; whence some writers give it the name of *furcella* or *furcula inferior*; or else it is unossified, in the middle.—In the greatest number of adults it is ossified and tipped with a cartilage; in some one end of it is cartilaginous, and in others it is all in a cartilaginous state.—Generally several oblique ligaments fixed at one end to the cartilage of the ribs, and by the other to the outer surface of the *xiphoid* bone, connect it firmly to those cartilages (*a*).

So many different ways this small bone may be formed, without any inconvenience. But then some of these positions may be directed, as to bring on a great train of consequences; particularly, when the lower end is ossified, and is too much turned outwards or inwards (*b*), or when the conjunc-

(*a*) Weitbrecht, Syndesmolog. p. 121.

(*b*) Rolinc. Dissert. anat. lib. 2. cap. 41.—Pars ossib. part 1. cap. 3. & part 3. cap. 3.—Codronchi de pro-  
su cartilagin. mucronat.

on of this *appendix* with the second bone is weak (*a*).

The *sternum* is joined by cartilages to the seven upper ribs, unless when the first coalesces with it in an intimate union of substance; and its unequal cavity on each side at its upper end is fitted for the ends of the ribs.

The *sternum* most frequently has four round bony parts, surrounded with cartilage, in children born at the full time; the uppermost of which is the first bone, being the largest. — Two or three other very small bony parts are likewise to be seen in several children. — The number of bones increases for some years, and then diminishes, but uncertainly, till they are at last united into those above described of an adult.

The uses of this bone are, to afford origin and insertion to several muscles; to sustain the *thorax*, to defend the vital organs, the heart and lungs, at the fore-part; and, lastly, by serving as a moveable *fulcrum* of the arm, to assist considerably in respiration: which action, so far it depends on the motion of the bones, we are now at liberty to explain.

When the ribs that are connected by their cartilages to the *sternum*, or to the cartilages of the true ribs, are acted upon by the intercostal muscles, they must all be pulled from the oblique

Paaw, *ibid.* — Borrich. *act. Hafn.* vol. 5. ob. 79. — Bæpulchret. *anat. tom. 2. lib. 3. § 5.* Append. ad obs. *ibid.* § 7. obs. 19.

oblique position which their cartilages bring them in, nearer to right angles with the *tebrae* and *sternum*, because the first or uppermost rib is by much the most fixed of all, and the cartilages making a great resistance raising the anterior ends of the ribs, the large arched middle parts turn outwards as well as upwards.—The *sternum*, pressed strong on both sides by the cartilages of the ribs, is pushed forwards, and that at its several parts in proportion to the length and motion of its supporters, the ribs; that is, most at its lower end.—The *sternum* and the cartilages, raised forwards, must draw the *diaphragm* connected to them; consequently so far stretch it and bring it nearer to a plane.—The process that raises this bone and the cartilages, stretches them sufficiently to make them resist the action of the *diaphragm*, whose fibres contract at the same time, and thrust the *viscera* of the *men* downwards.—The arched part of the ribs being thus moved outwards, their anterior ends and the *sternum* being advanced forwards, and the *diaphragm* being brought nearer to a plain surface, instead of being greatly convex on each side within each cavity of the thorax, it is evident how considerably the cavity is enlarged, which the nine or ten upper ribs are the cause of. It must be widened, and made deeper and larger.—While this is doing in the upper ribs, the lower ones, whose cartilages are not joined to the *sternum* or to other cartilages, move very differently, though they conspire to the same intention, the enlargement of the *thorax*: For having no fixed point to which

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erior ends are fastened, and the *diaphragm* is inserted into them at the place where it is pretty straight upwards from its origin at the *vertebrae*, these ribs are drawn downwards by this strong muscle, and by the muscles of the *abdomen*, which, at this time, are resist- the stretching force of the bowels; while the intercostal muscles are pulling them in the contrary direction, to wit, upwards: The effect therefore of either of these powers, which are antagonists to each other, is very little, as in moving the ribs either up or down; but the muscles of the *abdomen*, pushed at this time upwards by the *viscera*, carry these ribs along with them.—Thus the *thorax* is not only not allowed to be shortened, but is really widened in its lower part, to assist in making sufficient room for the due distension of the lungs.

As soon as the action of these several muscles ceases, the elastic cartilages extending themselves to their natural situation, depress the upper ribs, and the *sternum* subsides;—the *diaphragm* is thrust up by the *viscera abdominalia*, and the oblique and transverse muscles of the belly serve to draw the inferior ribs inwards at the same time.—By these causes, the gravity of the breast is diminished in all its motions.

Though the motions above described of the ribs and *sternum*, especially of the latter bone, are so small in the mild respiration of a healthy person, that we can scarce observe them; they are manifest whenever we designedly suspend our respiration, or are obliged to do so by exercise, and in several diseases.

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O F

## OF THE SUPERIOR EXTREMITIES

**A**uthors are much divided in their opinion about the number of bones which constitute the *superior extremity* \* should be said to consist of some describing the *clavicle* and *scapula* as parts of it, others classing these two bones with the bones of the *thorax*: But since most quadrupeds have no *clavicles*, and the human *thorax* can perform its functions right when the *scapula* is taken away (a), whereas it is impossible for it to have the right use of our arms without these bones; I must think that they belong to the *superior extremities*; and therefore I divide each of them into the *shoulder*, *fore-arm*, and *hand*.

The *SHOULDER* consists of the *clavicle* and *scapula*.

*CLAVICULA*, or *collar-bone* †, is the crooked bone, in figure like an *Italic f*, placed almost horizontally between the upper lateral part of the *sternum*, and what is commonly called the top of the shoulder, which, like a *clavis* or beam, it bears off from the trunk of the body.

The *clavicle*, as well as other long bones, is larger at its two ends, than in the middle. The end next to the *sternum* is triangular.

\* *Κωλαί, γυναι, ἐκφυαδεις*, Enata, adnata, explantata manus.

(a) Philosoph. transact. numb. 449. § 5.

† *Os jugulare, jugulem, furcula, ligula, clavis, huiusmodi quibusdam.*

‡ *Παρασφαγίς.*

angular: The angle behind is considerably produced, to form a sharp ridge, to which the transverse ligament extended from one clavicle to the other is fixed (*a*).—The side opposite to this is somewhat rounded.—The middle of this tuberculant end is as irregularly hollowed, as the cavity in the *sternum* for receiving it is raised; but in a recent subject, the irregular concavities of both are supplied by a moveable cartilage, which is not only much more closely connected every where by ligaments to the circumference of the articulation, than those of the lower jaw are; but it grows to the two bones at both its internal and external end; its substance at the internal end being soft, but very strong, and resembling the intervertebral cartilages (*b*).

From this internal end, the *clavicle*, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper fore-part of this curvature a small ridge is seen, with a plain rough surface before it; whence the *musculus sterno-hyoideus* and *sterno-thyroideus* have in part their origin.—Near the lower angle a small plain surface is often to be remarked, where the first rib and this bone are contiguous (*c*), and are connected by a transverse ligament (*d*).—From this a rough plain surface is extended outwards, where the pectoral

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ral

(1) Riolan. Encheirid. anat. lib. 6. cap. 13.—Winslow, anat. des os frais, § 248.—Weitbrecht. Act. Petro-  
tom. 4 p. 255. et Syndesmolog. sect. 2. I. § 3.

(2) Weitbrecht, Syndesmolog. sect. 2. I. § 6.

(3) Dionis, Sixieme demonst. des os.

(4) Weitbrecht, Syndesmolog. sect. 2. I. § 7.

ral muscle has part of its origin.——Behind the bone is made flat and rough by the insertion of the larger share of the subclavicular muscle.——After the clavicle begins to be bended backwards, it is round, but soon afterwards becomes broad and thin; which shape it retains to its external end.——Along the external concavity, a rough sinuosity runs, from which some part of the deltoid muscle takes its origin.

——Opposite to this, on the convex edge a scabrous ridge gives insertion to a share of the *trapezoidalis* muscle. The upper surface of the clavicle here is flat; but the lower is hollowed for lodging the beginning of the *musculus coracobrachialis*; and towards its back-part a tubercle rises, to which, and a roughness near it, a strong short thick ligament connecting this bone to the coracoid process of the *scapula* is fixed.

The external end \* of this bone is horizontally oblong, smooth, sloping at the posterior side, and tipped in a recent subject with a cartilage, for its articulation with the acromion of the *scapula*.——Round this the bone is spongy, and the firmer connection of the ligaments.

The medullary arteries, having their direction obliquely outwards, enter the clavicle by one or more small passages in the middle of their back part.

The substance of this bone is the same as the other round long bones.

The triangular unequal interior end of each clavicle, has the cartilage above described interposed betwixt it and the irregular cavity of the *sternum*.——The ligament

\* *Encephalon*.

which surround this articulation to secure are so short and strong, that little motion can be allowed any way; and the strong ligament that is stretched across the upper extremity of the *scapula* of the *sternum*, from the posterior prominent angle of the one clavicle, to the same place of the other clavicle, serves to keep both of these bones more firmly in their place.—By the assistance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raised or depressed, and moved backwards and forwards so much, as that the sternal end, which is at a great distance from the axis, enjoys very conspicuous motions.—The articulation of the exterior end of the clavicle shall be considered after the description of the *scapula*.

The clavicles of infants are not deficient in any of their parts; nor have they any epiphyses at their extremities joined afterwards to their bodies, as most other such long bones have, which preserves them from being bended too much, and from the danger of any unossified parts being separated by the force which is exerted in moving the arms forwards.

The uses of the clavicles are, to keep the *scapula*, and consequently all the *superior extremities*, from falling in and forward upon the *sternum*; by which, as in most quadrupeds, the motions of the arms would be much confined, and the breast made too narrow.—The clavicles likewise afford origin to several muscles, and a defence to large vessels.

From the situation, figure, and use of the clavicles, it is evident, that they are much exposed.



posed to fractures; that their broken parts generally go by each other; and that they are difficultly kept in their place afterwards.

*SCAPULA*, or *shoulder-blade* \*, is the angular bone situated on the out-side of the ribs, with its longest side called its base, towards the spinal processes of the vertebrae, and with the angle at the upper part of this side about three inches, and the lower angle at a greater distance from these processes.—The back part of the *scapula* has nothing but the thin ends of the *ferratus anticus major* and *subscapularis* muscles between it and the ribs: But as this bone advances forwards, the distance from the ribs increases.—The upper or shortest side, called the *superior costa* of the *scapula* is nearly horizontal, and parallel with the second rib.—The lower side, which is named the *inferior costa*, is extended obliquely from the third to the eighth rib.—The position of this bone, here described, is when people are sitting or standing in a state of activity, and allowing the members to remain in the most natural easy posture.—The anterior angle of the *scapula* is very acute; the superior one is near to a right angle; and what is called the anterior, does not deserve the name, for the two sides do not meet to form an angle.—The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorsum* †.—Three processes are

\* Ὠμοπλάτος, ἐπ' αὐτῷ, latitudo humeri, scapulae, scutulum opertum, spatula, ala, humerus, clypeus, thoracis.

† Χεῖρ, manus.

erally reckoned to proceed from the *scapula*.

—The first is the large spine that rises from the convex surface behind, and divides it unequally. —The second process stands out from the fore-part of the upper side; and, from its imaginary resemblance to a crow's beak, is named *coracoides* \*. —The third process is the whole thick bulbous fore-part of the bone.

After thus naming the several constituent parts of the *scapula*, the particular description will be more easily understood.

The *base*, which is tipped with cartilage in young subjects, is not all straight: For above the spine, it runs obliquely forwards to the superior angle; that here it might not be too protuberant backwards, and so bruise the muscles and teguments: Into the oblique space the *sculus patientia* is inserted. —At the root of the spine, on the back-part of the base, a triangular plain surface is formed, by the pressure of the lower fibres of the *trapezius*. —Now this the edge of the *scapula* is scabrous and rough, for the insertion of the *serratus anterior* and *rhomboid* muscles.

The back-part of the inferior angle is made smooth by the *latissimus dorsi* passing over it. This muscle also alters the direction of the *inferior costa* some way forwards from this angle: so far it is flattened behind by the origin of *teres major*. —As the *inferior costa* advances forward, it is of considerable thickness, is partly hollowed and made smooth behind by *teres minor*, while it has a *fossa* formed into

*Anchoroides, sigmoides, digitalis, anastroides.*

into it below by part of the *subscapularis*; and between the two a ridge with a small depression appears, where the *longus extensor cubiti* has its origin.

The *superior costa* is very thin; and near its fore-part there is a semilunar notch, from one end of which to the other a ligament is stretched; and sometimes the bone is continued, to form one, or sometimes two holes for the passage of the scapular blood-vessels and nerves.——Immediately behind this semilunar cavity the *coraco hyoid* muscle has its rise.——From the notch to the termination of the *foramen* for the *teres minor*, the *scapula* is narrower than any where else, and supports the third process. This part has the name of *cervix*.

The whole *dorsum* of the *scapula* is always said to be convex; but, by reason of the raised edges that surround it, it is divided into two cavities by the spine, which is stretched from behind forwards, much nearer to the superior than to the inferior *costa*.——The cavity above the spine is really concave where the *supra-spinatus* muscle is lodged; while the surface of the bone below the spine, on which the *infraspinatus* muscle is placed, is convex, except a *fossa* that runs at the side of the inferior *costa*.

The internal or anterior surface of this bone is hollow, except in the part above the spine which is convex.——The *subscapularis* muscle is extended over this surface, where it forms several ridges and intermediate depressions commonly mistaken for prints of the ribs; they point out the interstices of the bundles

res of which the *subscapularis* muscle is composed (a).

The spine \* rises small at the base of the scapula, and becomes higher and broader as it advances forewards. — On the sides it is unequally hollowed and crooked, by the actions of the adjacent muscles. — Its ridge † is divided into two rough flat surfaces : Into the upper one, the *trapezius* muscle is inserted ; and the lower one has part of the *deltoid* fixed to

— The end of the spine, called *acromion* ‡, or top of the shoulder, is broad and flat, and is sometimes only joined to the spine by a cartilage (b). — The anterior edge of the scapula is flat, smooth, and covered with a cartilage, for its articulation with the external end of the clavicle ; and it is hollowed below, to allow a passage to the *infra* and *supraspinati* muscles, and free motion to the os humeri.

The *coracoid* § process is crooked, with its point inclining forewards ; so that a hollow is formed at the lower side of its root, for the passage of the *infra-scapularis* muscle. — The end of this process is marked with three distinct surfaces. Into the internal, the *serratus minor anticus* is inserted : From the external one head of the *biceps flexor cubiti* rises ; from the lower one, the *coracobrachialis* has

Winflow, in Memoires de l' acad. des sciences, 1712.

ἄκρῃς, ὑπερόχῃ ὀμοπλάτων, eminentia scapularum.

Pterigium, crista.

ἄκρῃς ἀγκυροειδῆς, κορακοειδῆς, κατακλῆς, acromii os, os armus, rostri in porcinum, processus digitalis,

Sue Trad. d' osteol. p. 160.

ἄγκυροειδῆς, σίγμοειδῆς, rostriformis.

has its origin. — At the upper-part of the root of this process, immediately before the *semilunar* cavity, a smooth tubercle appears where a ligament from the *clavicle* is fixed. From all the external side of this *coracoid apophyse*, a broad ligament goes out, which becomes narrower where it is fixed to the *acromion*. — The sharp pain, violent inflammation, and tedious cure of contusions in this part, are probably owing to these tendons and ligaments being hurt.

From the *cervix scapulae* the third process is produced. The fore-part of this is formed into a *glenoid* cavity \*, which is of the shape of the longitudinal section of an egg, being broad below, and narrow above. — Between the brims of this hollow and the fore-part of the root of the spine, a little sinuosity is left for the transmission of the *supra* and *infra spinati* muscles; and on the upper-part of these brims we may remain a smooth surface, where the second head of the *biceps flexor cubiti* has its origin. — The root of the *supercilia* is rough all round, the firmer adhesion of the capsular ligament of the articulation, and of the cartilage which is placed on these brims, where it is thick but becomes very thin as it is continued towards the middle of the cavity, which it lies all over.

The medullary vessels enter the *scapula* at the base of the spine.

\* *Αμφοτίλις.*



The substance of the *scapula*, as in all other broad flat bones, is cellular, but of an unequal thickness; for the neck and third process are thick and strong. The inferior *costa*, spine, and coracoid process, are of a middle thickness; and the body is so pressed by the muscles, as to become thin and diaphanous.

The *scapula* and clavicle are joined by plain surfaces, tipped with cartilage \*; by which either bone is allowed any considerable motion, being tightly tied down by the common capsular ligament, and by a very strong one which proceeds from the coracoid process; it divides into two before it is fixed into the *clavicle*, with such a direction, as either to allow this bone to have a small rotation, in which its posterior edge turns more backwards, while the anterior one rises farther forwards; or it can yield to the force of the *scapula* moving downwards, while the back-part of it is drawn upwards; in both such cases, the oblong smooth articulated surfaces of the *clavicle* and *scapula* are not in the same plane, but stand a little transversely, across each other, and thereby preserve the joint from luxations, to which it would be subject, if either of the bones was to move the other perpendicularly up and down, without any rotation. — Sometimes a moveable ligamentous cartilage is found in this joint; otherwhiles such a cartilage is only supposed at the anterior half of it; and in the old subjects I have found a sesamoid bone

Acromion, *κατακλις*, clausura.

bone here (a). — The *scapula* is connected to the head, *os hyoides*, *vertebra*, ribs, and arm-bone, by muscles, that have one end fastened to these bones, and the other to the *scapula*, which can move it upwards, downwards, backwards, or forewards; by the quick succession of these motions, its whole body is carried in a circle. But being also often moved as upon an axis perpendicular to its plane, its circumference turns in a circle whose center the axis is (b). Whichever of these motions it performs, it always carries the outer end of the clavicle and the arm along with it. — The *glenoid* cavity of this bone receives the *os humeri*, which plays in it as a ball in a socket, as will be explained more hereafter.

The use of the *scapula* is, to serve as a fulcrum to the arm; and, by altering its position on different occasions, to allow always the head of the *os humeri* a right situation in its socket to move in; and thereby to assist to enlarge greatly the motions of the superior extremity, and to afford the muscles which arise from it more advantageous actions, by altering their directions to the bone where they are to move. — This bone also serves to defend the back-part of the *thorax*, and is often employed to sustain weights, or to resist forces, too great for the arm to bear.

The base, *acromion*, coracoid process, and head of the *scapula*, are all in a cartilaginous state at birth; and the three first are joined as *epiphyses*; while the head, with the *glenoid* cavity

(a) Jac. Sylv. *Isagog. anat.* lib. 1. cap. 2.

(b) See Winslow, *Memoires de l'acad. des sciences*, 1710.

ity, is not formed into a distinct separate bone, but is gradually produced by the ossification of the body of this bone being continued forwards.

The *ARM* has only one bone, best known by the *Latin* name of *os humeri* \*; which is round and nearly straight.

The upper end of this bone † is formed into a large round smooth head, whose middle is not in a straight line with the axis of the bone, but stands obliquely backwards from

—The extent of the head is distinguished by a circular *fossa* surrounding its base, where the head is united to the bone, and the capsular ligament of the joint is fixed.——Below

the fore-part of its base two tubercles stand

The smallest one, which is situated most towards the inside, has the tendon of the *subscapularis* muscle inserted into it.——The larger more

external protuberance is divided, at its upper

part, into three smooth plain surfaces; into

the anterior of which, the *musculus supra-spina-*

mus is inserted into the middle or largest, the *infra-spina-*

mus into the one behind, the *teres minor*, is

inserted.——Between these two tubercles, ex-

tending in the fore-part of the bone, a deep long

furrow is formed, for lodging the tendinous head

of the *biceps flexor cubiti*; which, after passing,

in a manner peculiar to itself, through the

middle of the articulation, is tied down by a

tendinous sheath extended across the *fossa*; in

the middle, and in the neighbouring tubercles, are

X

several

*ἄστρον, ὀστέον* os brachii, *ἄστρον* adjutorium, *parvum*  
*canalis*, *canna* brachii,  
*microcolium*,

several remarkable holes, which are penetrated by the tendinous and ligamentous fibres and by vessels.—On each side of this bone as it descends in the *os humeri*, a rough ridge gently flattened in the middle, runs from the roots of the tubercles.—The tendon of the *pectoral* muscle is fixed into the anterior of these ridges, and the *latissimus dorsi*, and *teres major*, are inserted into the internal one.—A little behind the lower end of this bone another rough ridge may be observed, where the *coraco-brachialis* is inserted.—From the back part of the root of the largest tubercle a ridge also is continued, from which the *ulna* *extensor cubiti* rises.—This bone is flattened on the inside, about its middle, by the body of the *biceps flexor cubiti*.—In the middle of this plain surface, the entry of the median artery is seen slanting obliquely downwards.—At the fore side of this plane the bone rises in a sort of ridge, which is rough, and often has a great many small holes in it, where the tendon of the strong *deltoid* muscle is inserted; on each side of which the bone is smooth and flat, where the *brachialis internus* rises. The exterior of these two flat surfaces is the largest; behind it a superficial channel, formed by the muscular nerve and the vessels that accompany it, runs from the hind forewards and downwards.—The back of the *os humeri* is flattened behind by the tendons of the fore-arm.—Near the lower end of this bone, a large sharp ridge is extended on its outside, from which the *musculus spinator radii longus*, and the long

ad of the *extensor carpi radialis* rise.—  
 opposite to this, there is another small ridge  
 which the *aponeurotic* tendon, that gives  
 origin to the fibres of the internal and external  
*brachii* muscles is fixed; and from a little  
 depression on the fore-side of it, the *pronator*  
*quadratus* rises.

The body of the *os humeri* becomes gra-  
 dually broader towards the lower end, where  
 it has several processes; at the roots of which,  
 there is a cavity before, and another behind \*.  
 The anterior is divided by a ridge into two;  
 the external, which is the least, receives the  
 head of the *radius*; and the internal receives  
 the *coronoid* process of the *ulna* in the flexions  
 of the fore-arm, while the posterior deep  
 angular cavity lodges the *olecranon* in the  
 extensions of that member.——The bone be-  
 tween these two cavities is pressed so thin by  
 the processes of the *ulna*, as to appear diapha-  
 nous in several subjects.——The sides of the  
 anterior cavity are stretched out into two pro-  
 cesses, one on each side: These are called  
*condyles*; from each of which a strong liga-  
 ment goes out to the bones of the fore arm.  
 —The external *condyle*, which has an ob-  
 lique direction also forewards in respect of the  
 humerus, when the arm is in the most natural  
 posture (a), is equally broad, and has an ob-  
 long smooth head rising from it forewards.——  
 From the rough part of the *condyle*, the in-  
 terior head of the *bicornis*, the *extensor di-*  
*gitum communis*, *extensor carpi ulnaris*, an-

X. 2. *conexus*,

Winflow.

Winflow, Memoires de l'acad. des sciences, 1722.



*conexus*, and some part of the *supinator radius brevis*, take their rise; and on the smooth head the upper end of the *radius* plays.—Immediately on the outside of this, there is a sinuosity made by the shorter head of the *bicornis* muscle, upon which the *musculus nervus* is placed.—The internal condyle is more pointed and protuberant than the external, to give origin to some part of the *flexor carpi radialis*, *pronator radii teres*, *palmaris longus*, *flexor digitorum sublimis*, and *flexor carpi ulnaris*.—Between the two condyles, is the *trileta* or pulley, which consists of two lateral protuberances, and a middle cavity, that are smooth and covered with cartilage—When the forearm is extended, the tendon of the internal *oblique* muscle is lodged in the fore part of the cavity of this pulley.—The external protuberance, which is less than the other, has a sharp edge behind; but forewards, this ridge is smooth, and only separated from the little head already described, by a small *fissa*, in which the joined edges of the *ulna* and *radius* move.—The internal protuberance of the pulley is larger and highest; and therefore in the motion of the *ulna* upon it, that bone would be inclined outwards, was it not supported by the *radius* on that side.—Between this internal protuberance and condyle, a sinuosity may be remarked, where the *ulnar* nerve passes.

The substance and the internal structure of the *os humeri* is the same, and disposed in the same way, as in other long bones.

The round head at the upper end of the bone is articulated with the *glenoid* cavity

the *scapula*; which being superficial, and having long ligaments, allows the arm a free and extensive motion. — These ligaments are however considerably strong. For, besides the common capsular one, the tendons of the muscles perform the office, and have been described under the name of *ligaments*. — Then the *acromion* and *coracoid* process, with the strong broad ligaments stretched betwixt them, secure the articulation above, where the greatest and most frequent force is applied to thrust the head of the bone out of its place. It is true that there is not near so strong a defence in the lower part of the articulation; but in the ordinary postures of the arm, that is, so long as it is at an acute angle with the trunk of the body, there cannot be any force applied at this place to occasion a luxation, since the joint is protected so well above.

The motions which the arm enjoys by this articulation, are to every side; and by the succession of these different motions, a circle may be described. Besides which, the bone performs a small rotation round its own *axis*. — though this can be performed with the hand and head in all positions; yet as these vary, the effects upon the body of the bone are very different: For, if the middle of the head be the center of rotation, as it is when the arm hangs down by the side, the body of the bone is only moved forwards and backwards; because the *axis* of motion of the head is near-

ly at right angles with the length of the bone (a); whereas, when the arm is raised to right angles with the trunk of the body, the center of motion, and the axis of the bone, come to be in the same straight line; and therefore the body of the *os humeri* performs the same motion with its head.———Though the motions of the arm seem to be very extensive, yet the larger share of them depends on the motion of the *scapula*.—The lower end of the *os humeri* is articulated with the bones of the fore-arm, and carries them with it in its motions, but serves as a base on which they perform the motions peculiar to themselves; shall be described afterwards.

Both the ends of this bone are cartilaginous in a new-born infant, and the large head and the two tubercles, and the *trochlea* with the two *condyles*, become *epiphyses* before they are united to the body of the bone.

The *FORE-ARM* † consists of two bones, the *ulna* and *radius*; whose situation in respect of each other, is oblique in the straining or most natural posture; that is, the *ulna* is not directly behind, nor on the outside of the *radius*, but in a middle situation between these two, and the *radius* crosses it.—The situation however of these two bones, and of the other bones of the *superior extremity* are not yet described, is frequently altered; therefore, to shun repetitions, I desire it may now be remarked, that, in the remaining account of the *superior extremity*, I understand by

(a) Hippocrat. de articul. § 1.

† Cubitus, πῦχος, ὠλήν, πυγών, ulna, lacertus.

of *posterior*, that part which is in the same direction with the back of the hand; *anterior*, that answering to the palm; by *internal*, that on the same side with the thumb; *external*, the side nearest to the little finger; supposing the hand always to be in a middle position between *pronation* and *supination*.

*ULNA* †, so named from its being used as a measure, is the longest of the two bones of the arm, and situated on the outside of the humerus.

At the upper end of the *ulna* are two processes.—The posterior is the largest, and formed like a hook, whose concave surface moves upon the pulley of the *os humeri*, and is called *olecranon* ‡, or top of the cubit.—The convex part of it is rough and scabrous, where the *musculus brevis*, and *brachiceus externus*, are inserted. The *olecranon* makes it unnecessary that the tendons of the extensor muscles should pass over the end of the *os humeri*; which would have been of ill consequence in the great motions of this joint, or when any considerable external force is applied to this part (*a*).—The anterior process is not so large, nor does it reach so high as the one behind; but is sharper at its point, and therefore is named *coronoid*.—Between the two processes, a large semicircular or sigmoid concavity is left; the surface of which,

on

Cubitus, πῆχυς, προπῆχρον, fœcile majus, canna vel arundo  
et inferior brachii.

Πυχῶν, gibber cubitus, additamentum necatum.

Winslow, Exposition anatomique du corps humain,  
des os secs, § 279.

on each side of a middle rising, is slanting, and exactly adapted to the pulley of the bone of the arm.——Across the middle of it, there is a small sinuosity for lodging mucilaginous glands, where, as well as in a small hollow on the external side of it, the cartilage that lines the rest of its surface is wanting.——Round the brims of this concavity the bone is rough, where the capsular ligament of the joint is implanted.——Immediately below the olecranon on the back-part of the *ulna*, a flat triangular spongy surface appears, on which we commonly lean.—At the internal side of this, there is a larger hollow surface, where the *musculus conæus* is lodged; and the ridge at the inner end of this gives rise to the *musculus supinator brevis*.——Between the top of the ridge and the coronoid process is the semilunar cavity, lined with cartilage, in which, a ligament extended from the one to the other end of this cavity, the round head of the radius plays.—Immediately below it a rough hollow gives lodging to mucilaginous glands.—Below the root of the coronoid process, this bone is broad and unequal, where the *brachæus internus* is inserted.—On the outside of that we observe a smooth concavity, where the beginning of the *flexor digitorum profundus* sprouts out.

The body of the *ulna* is triangular.—The internal angle is very sharp, where the ligament that connects the two bones is fixed. The sides, which make this angle, are flattened and rough, by the action and adhesion of the muscles which are situated here.——At

dis



stance of one third of the length of the *ul-*  
 from the top, in its fore-part, the passage of  
 the medullary vessels is to be remarked slanting  
 upwards. — The external side of this bone is  
 smooth, somewhat convex, and the angles at  
 each edge of it are blunted by the pressure of  
 the muscles equally disposed about them.

As this bone descends, it becomes gradually  
 smaller; so that its lower end terminates in a  
 small head, standing on a small neck. — To-  
 wards the fore but outer part of which last, an  
 oblique ridge runs, that gives rise to the *pro-*  
*cessus radii quadratus*. — The head is round,  
 smooth, and covered with a cartilage on its in-  
 ternal side, to be received into the semilunar  
 cavity of the *radius*; while a *styloid* process  
 rises from its outside, to which is fixed a strong  
 ligament that is extended to the *os cuneiforme*  
*et pisiforme* of the wrist. — Between the back-  
 of that internal smooth side and this pro-  
 cess, a sinuosity is left for the tendon of the  
*extensor carpi ulnaris*. — On the fore-part of  
 the root of the process, such another depres-  
 sion may be remarked for the passage of the  
 artery and nerve. — The end of the bone is  
 smooth, and covered with a cartilage. — Between  
 and the bones of the wrist, a doubly-con-  
 cave moveable cartilage is interposed; which is  
 a continuation of the cartilage that covers the  
 lower end of the *radius*, and is connected loose-  
 ly to the root of the *styloid* process, and to the  
 deep cavity there; in which mucilaginous  
 fluids are lodged.

The

*Capitulum, malleolus externus.*

The *ulna* is articulated above with the lower end of the *os humeri*, where these bones have depressions and protuberances corresponding each other, so as to allow an easy and free extension of the fore-arm to almost a straight line with the arm, and flexion to a very acute angle; but, by the slanting position of the pulley, the lower part of the fore-arm is turned outwards in the extension, and inwards in flexion (*a*); and a very small kind of rotation is likewise allowed in all positions, especially when the ligaments are most relaxed by the fore-arm being in a middle degree of flexion. — The *ulna* is also articulated with the *radius* and *carpus*, in a manner to be related afterwards.

*RADIUS* \*, so called from its imagined resemblance to a spoke of a wheel, or to a weaver's beam, is the bone placed at the inside of the fore-arm. Its upper end is formed into a circular little head, which is hollowed for articulation with the tubercle at the side of the pulley of the *os humeri*; and the half of the round circumference of the head next to the *ulna* is smooth, and covered with a cartilage, in order to be received into the semicircular cavity of that bone. — below the head the *radius* is much smaller; therefore this part is named its *cervix*, which is made round by the action of the *supinator radii brevis*. — At the external root of this neck, a tuberculous process rises; into the outer part of which the *ceps flexor cubiti* is inserted. — From the ridge runs downwards and inwards, where

(a) Winslow, Memoires de l'acad. des sciences, 1722.

\* *Κερχίς, παραπύχιον*, *focile minus*, *canna minor*, *minor*.

*pronator radii brevis* is inserted; and a little below, and behind this ridge, there is a rough bony surface, where the *pronator radii teretis* is fixed.

The body of the *radius* is not straight, but convex on its internal and posterior surfaces; where it is also made round by the equal pressure of the circumjacent muscles, particularly the *extensors* of the thumb; but the surfaces next to the *ulna* are flattened and rough, for the origin of the muscles of the hand; and they terminate in a common sharp spine, to which the strong ligament extended betwixt the two bones of the fore-arm is fixed.—A little below the beginning of the plain surface, on its inner-part, where the *flexor* muscle of the last phalanx of the thumb takes its origin, the passage of the medullary vessels is seen slanting upwards.—The *radius* becomes broader and flatter towards the lower end, especially on its fore-part, where its *pronator quadratus* muscle is situated. The lower end of the *radius* is larger than the superior; though not in such a disproportion as the upper end of the *ulna* is larger than the lower end.—Its back-part has a flat strong surface in the middle, and *fossæ* on each side.—A small groove, immediately on the outside of the ridge, the tendon of the *extensor tertii pollicis* plays.—In a large one being this, the tendons of the *indicator* and of the common *extensor* muscles of the fingers.—Contiguous to the *ulna*, there is a small depression made by the *extensor minimi digiti*. On the inside of the ridge there is a broad depression,

depression, which seems again subdivided, where the two tendons of the *bicornis*, or *extensor carpi radialis*, are lodged.—The internal side of this end of the *radius* is also hollowed out for the extensors of the first and second joints of the thumb; immediately above which, a little rough surface shews where the *supinator longus* is inserted.—The ridges at the sides of the grooves, in which the tendons pass, have an annular ligament fixed to them, which the several sheaths for the tendons are formed.—The fore-part of this end of the *radius* is also depressed, where the flexors of the fingers and *flexor carpi radialis* pass.—The external side is formed into a semilunar smooth cavity, lined with a cartilage, for receiving the lower end of the *ulna*.—The lowest part of the *radius* is formed into a long cavity; in the middle of which is a small transverse rising, gently hollowed, for lodging mucilaginous glands; while the rising itself is insinuated into the conjunction of the two bones of the wrist that are received into the cavity.—The internal side of this articulation is fenced by a remarkable process \* of the *radius*, from which a ligament goes out to the wrist, as the *styloid* process of the *ulna* with its ligament guards it on the outside.

The ends of both the bones of the arm being thicker than the middle, there is a considerable distance between the bodies of these bones; in the larger part of which a strong tendinous, but thin ligament, is extended, to give a large enough surface for the

\* Malleolus internus, processus styloides.

the numerous fibres of the muscles situated there, that are so much sunk between the bones, to be protected from injuries, which they would otherwise be exposed to. But this ligament is wanting near the upper end of the forearm, where the *supinator radii brevis*, and *flexor digitorum profundus*, are immediately connected.

(a). Both ends of the bones of the fore-arm first cartilages, and then *epiphyses* in children.

As the head of the *radius* receives the tubercle of the *os humeri*, it is not only bended and extended along with the *ulna*, but may be moved round its *axis* in any position; and that this motion round its *axis* may be sufficiently large, the ligament of the articulation is extended further down than ordinary on the neck of this bone, before it is connected to it; and it is ventral at its upper and lower part, but makes a ring in the middle.—This bone is articulated to the *ulna* by a double articulation; above, a tubercle of the *radius* plays in a socket of the *ulna*; whilst below, the *radius* is the socket, and the *ulna* the tubercle: then the motion performed in these two is different; for at the upper end, the *radius* does no more than turn round its axis; while at the lower end, it moves in a sort of *cycloid* round the round part of the *ulna*; and as the *radius* is articulated and firmly connected here to the *ulna*, they must move together.—

Y

When



When the palm is turned uppermost, the *diuis* is said to perform the *supination*; when back of the hand is above, it is said to be *pr*. But then the quickness and large extent of the two motions are assisted by the *ulna*, which was before observed, can move with a kind of small rotation on the sloping sides of the *olecranon*. This lateral motion, tho' very inconspicuous in the joint itself, is conspicuous at the lower end of such a long bone; and the strong ligament connecting this lower end to the *carpal* makes the hand more readily to obey these motions.—When we design a large circular motion of our hand, we increase it by the rotation of the *os humeri*, and sometimes employ the *os* and *inferior extremities* to make these motions of pronation or supination of the hand less enough.

The *HAND* \* comprehends all from the base of the wrist to the points of the fingers. The back-part is convex, for greater firmness and strength; and it is concave before, for coming more surely and conveniently such bones as we take hold of.—One half of the *carpal* has an obscure motion in comparison of the other has, and serves as a base to the movable half; which can be extended backwards very little farther than to a straight line with the fore-arm, but can be considerably bended forwards.

As the bones that compose the hand are of different shapes and uses, while several of them that are contiguous agree in some general characters; the hand is, on this account, com-

\* Ἀπὸ χειρᾶ, *summa manus*.

divided into the *carpus*, *metacarpus*, and *fingers*; among which last the thumb is reckon-

The *CARPUS* \* is composed of eight small bony bones, situated at the upper part of the hand. I shall describe each of these bones, under a proper name taken from their figure; because the method of ranging them by numbers leaves anatomists too much at liberty to debate very idly, which ought to be preferred to the first number; or, which is worse, several, without explaining the order they observe, differently apply the same numbers, and so confound their readers.—— But that the description of these bones may be in the same order as they are found in the generality of anatomical books, I shall begin with the range of bones that are concerned in the moveable part of the wrist, or are connected to the arm, and shall afterwards consider the four that support the thumb and *ossa metacarpi* of the fingers.

The eight bones of the *carpus* are, or *scaphoides*, *lunare*, *cuneiforme*, *pisiforme*, *trapezium*, *trapezoides*, *magnum*, *unciforme*.

The *scaphoides* is situated most internally of those that are articulated with the fore-arm.—— The *lunare* is immediately on the outside of the former.—— The *cuneiforme* is placed still more externally, but does not reach so high up as the other two.—— The *pisiforme* stands forward into the palm from the *cuneiforme*.—— The *trapezium* is the first of the second row, and is situated betwixt the *scaphoides* and first joint

Y 2

of

Krug. brachiale, prima palmæ pars, rasetta.

Lyser. Cult. anat lib. 5. cap. 2.

of the thumb.—The *trapezoides* is immediately on the outside of the *trapezium*.—The *os magnum* is still more external.—The *unciforme* is farther to the side of the little finger.

*Os scaphoides* \* is the largest of the eight except one. It is convex above, concave and long below; from which small resemblance to a boat it has got its name.—Its smooth convex surface is divided by a rough middle furrow which runs obliquely cross it.—The upper largest division is articulated with the *radius*. Into the *fossa* the common ligament of the joint of the wrist is fixed; and the lower division is joined to the *trapezium* and *trapezoides*.—The concavity receives more than half of the round head of the *os magnum*. The external side of this hollow is formed to a semilunar plane, to be articulated with the following bone.—The internal, posterior and anterior edges are rough, for fixing ligaments that connect it to the surrounding bones.

*Os lunare* † has a smooth convex upper face, by which it is articulated with the *radius*.—The internal side, which gives name to the bone, is in the form of a crescent, and is joined with the *scaphoid*;—lower surface is hollow, for receiving part of the head of the *os magnum*.—On the inner side of this cavity is another smooth, but narrow oblong sinusity, for receiving the upper end of the *os unciforme*:—On the outside

\* Κερυκοειδές, naviculare.

† Lunatum.

which a small round convexity is found, for its connection with the *os cuneiforme*.—Between the great convexity above, and the first deep inferior cavity, there is a rough *fossa*, in which the circular ligament of the joint of the wrist is fixed.

*Os cuneiforme* \* is broader above, and towards the back of the hand, than it is below and forwards: which gives it the resemblance of a wedge.——The superior slightly convex surface is included in the joint of the wrist, being opposed to the lower end of the *ulna*.——Below this the cuneiform bone has a rough surface, wherein the ligament of the articulation of the wrist is fixed.——On the internal side of this bone, where it is contiguous to the *scaphoideum*, it is smooth and slightly concave.——On the lower surface, where it is contiguous to the *trapezoidale*, it is oblong, somewhat spiral, and concave.——Near the middle of its anterior surface a circular plane appears, where the *os pisiforme* is sustained.

*Os pisiforme* † is almost spherical, except one small plane, or slightly hollow surface, which is covered with cartilage for its motion on the *trapezoidale* bone, from which its whole rough surface is prominent forewards into the palm; the tendon of the *flexor carpi ulnaris*, and a ligament from the *styloid* process of the *ulna*, are fixed to its upper part; the *transverse* ligament of the wrist is connected to its internal side; ligaments extended to the *unciforme* bone, and to the *os metacarpi* of the

Y. 3

little

*Triquetrum.*

*Cartilaginofum, subrotundum, rectum.*



little finger, are attached to its lower part; the *abductor minimi digiti* has its origin from its fore-part; and, at the internal side of its small depression is formed, for the passage of the ulnar nerve.

*Trapezium*\* has four unequal sides and angles in its back-part, from which it has got its name——Above, its surface is smooth, slightly hollowed, and semicircular, for its junction with the *os scaphoides*.——Its external side is an oblong concave square, for receiving the following bone.——The inferior surface is formed into a pulley; the two preberant sides of which are external and internal. On this pulley the first bone of the thumb is moved.——At the external side of the internal protuberance, a small oblong smooth surface is formed by the *os metacarpi* index.——The fore-part of the *trapezium* is prominent in the palm, and, near to the external side, has a sinuosity in it, where the tendon of the *flexor carpi radiialis* is lodged on the ligamentous sheath of which the tendon of the *flexor tertii internodii pollicis* passes. And still more externally the bone is scabrous, where the *transverse* ligament of the wrist is connected, the *abductor* and *flexor primi internodii pollicis* have their origin, and ligaments go out to the first bone of the thumb.

*Os trapezoides* †, so called from the angular quadrangular figure of its back-part, is the smallest bone of the wrist, except the *pisiforme*.——The figure of it is an irre-

\* *Os culiforme, trapezoides, multangulum majus.*

† *Trapezium, multangulum minus.*



ube.——It has a small hollow surface above, by which it joins the *scaphoides*; a long convex one internally, where it is contiguous to the *trapezium*; a small external one, for its connection with the *os magnum*; and an inferior convex surface, the edges of which are however so raised before and behind, that a sort of sulley is formed, where it sustains the *os metacarpi indicis*.

*Os magnum* \*, so called because it is the largest bone of the *carpus*, is oblong, having four quadrangular sides, with a round upper end, and a triangular plain one below.——

The round head is divided by a small rising, opposite to the connection of the *os scaphoides* and *lunare*, which together form the cavity for receiving it.——On the inside a short plain surface joins the *os magnum* to the *trapezoides*.

——On the outside is a long narrow concave surface, where it is contiguous to the *os unciforme*.——The lower end, which sustains the metacarpal bone of the middle finger, is triangular, slightly hollowed, and farther advanced on the internal side than on the external, leaving a considerable oblong depression made in the advanced inside by the metacarpal bone of the fore-finger; and generally there is a small mark of the *os metacarpi digiti annularis* on its external side.

*Os unciforme* † has got its name from a thin broad process that stands out from it forwards into the palm, and is hollow on its inside, for affording passage to the tendons of the

\* Maximum, capitatum.

† Cuneiforme.

the flexors of the fingers. To this process also the transverse ligament is fixed, which binds down and defends these tendons; and the *flexor* and *abductor* muscles of the little finger have part of their origin from it.—The upper plain surface is small, convex, and joined with the *os lunare*:—The internal side is long, and slightly convex, adapted to the contiguous *os magnum*:—The external surface is oblique, and irregularly convex, to be articulated with the cuneiform bone:—The lower end is divided into two concave surfaces; the external is joined with the metacarpal bone of the little finger, and the internal one is fitted to the metacarpal bone of the ring-finger.

In the description of the preceeding eight bones, I have only mentioned those plain surfaces covered with cartilage, by which they are articulated to each other, or to some other bones, except in some few cases, where something extraordinary was to be observed, and I have designedly omitted the other rough surfaces, lest, by crowding too many words in the description of such small bones, the whole should be unintelligible: But these scabrous parts of the bones may easily be understood, after mentioning their figure, if it is observed, that they are generally found oriented towards the back or palm of the hand; that they are all plain, larger behind than before, and that they receive the different ligaments by which they are either connected to neighbouring bones, or to one another; for the ligaments cover all the bones, and are so accurately

ately applied to them, that, at first view, the whole *carpus* of a recent subject appears as a smooth bone (*a*).

As the surfaces of these bones are largest behind, the figure of the whole conjoined must be convex there, and concave before; which concavity is still more increased by the *pisiforme*, and process of the *os unciforme*, standing forwards on one side, as the *trapezium* does on the other: And the bones are securely kept in this form, by the broad strong transverse ligament connected to these parts of them that stand prominent into the palm of the hand.——The convexity behind renders the whole fabric stronger, where it is most exposed to injuries; and the large anterior hollow is necessary for a safe passage to the numerous vessels, nerves, and tendons of the fingers.

The substance of these bones is spongy and cellular, but strong in respect of their bulk.

The three first bones of the *carpus* make an oblong head, by which they are articulated with the cavity at the lower ends of the bones of the fore arm; so as to allow motion to the sides, and, by a quick succession of these motions, they may be moved in a circle. But the joint is oblong, and therefore the two dimensions are unequal, no motion is allowed the *carpus* round its axis, except what it has

) Glén. de usu part. lib. 2. cap. 3. For a particular description of these ligaments, see Weitbrecht. Syndesmolog. p. 63.

has in the pronation and supination along with the *radius*.——The articulation of the three bones of the superior row, with the bones of the inferior, is such as allows of motion, especially backwards and forwards; the security and easiness of which the reception of the *os magnum* into the cavity formed by the *scaphoides* and *lunare* contributes considerably: And the greatest number of muscles that serve for the motion of the wrist on the *radius*, being inserted beyond the junction of the first row of bones with the second, act equally on this articulation as they do on the former; but the joint formed by the *radius* being the most easily moved, the first effect of these muscles is on it; and the second row of the *carpus* is only moved afterwards. By this means a larger motion of the wrist is allowed, than otherwise it could have had safely: For, if as large motion had been given to one joint, the angle of flexion would have been very acute, and the ligaments would have been longer than was consistent with the firmness and security of the joint.——The other articulations of the bones here being by nearly plain surfaces, scarce allow of more motion, because of the strong connecting ligaments, than to yield a little, so elude the force of any external power, and to render the back of the wrist a little more flat, or the palm more hollow, on proper occasions. The articulations of the thumb and metacarpal bones shall be explained afterwards.



The uses of the *carpus* are to serve as a base for the hand, to protect its tendons, and to afford it a free large motion.

All the bones of the *carpus* are in a cartilaginous state at the time of birth.

On account of the many tendons that pass on the lower end of the fore-arm and the *carpus*, and of the numerous ligaments of these tendons and of the bones, which have lubricating liquors supplied to them, the pain of sprains is acute, the parts take long time to recover their tone, and their swellings are very obstinate.

**METACARPUS** \* consists of four bones which sustain the fingers.——Each bone is long and round, with its ends larger than its middle.——The upper end, which some call the head, is flat and oblong, without any considerable head or cavity; but it is however somewhat hollowed, for the articulation with the *carpus*: It is made flat and smooth on the sides where these bones are contiguous to each other.——Their bodies are flattened on their back-part towards the tendons of the extensors of the fingers.——The anterior surface of these bodies is a little concave, especially in their middle; along which a sharp ridge stands out, which separates the *musculi interossei* placed on each side of these bones which are there made flat and plain by the muscles.

Their lower ends are raised into large oblong smooth heads, whose greatest extent is towards from the axis of the bone.—At the fore-

ἄκρως, προκαρπιον, σῆδος, ἀνδρην, κτενιον, postbrachiale, palma. pecten.



fore-part of each side of the root of each these heads, one or two tubercles stand out, fixing the ligaments that go from one metacarpal bone to another, to preserve them from being drawn asunder:—Round the heads a rounding may be remarked, for the capsular ligaments of the first joints of the fingers to be added to; and both sides of these heads are fixed by pressing on each other.

The substance of the metacarpal bones is the same with that of all long bones.

At the time of birth, these bones are cartilaginous at both ends, which afterwards become epiphyses.

The metacarpal bones are joined above the *ossa carpi* and to each other by nearly plane surfaces. These connections are not fit for large motions.—The articulation of their roots at the lower ends with the cavities of the first bones of the fingers, is to be taken notice of hereafter.

The concavity on the fore-part of these metacarpal bones, and the placing their bases on the arched *carpus*, cause them to form a hollow in the palm of the hand, which is useful to us.—The spaces between them lodge muscles, and their small motion makes them fit supports for the fingers to play on.

Though the *ossa metacarpi* so far agree, they may be distinguished from each other by the following marks.

The *os metacarpi indicis* is generally the longest.—Its base, which is articulated with

*trapezoides*, is hollow in the middle.—The small ridge on the internal side of this oblong cavity is smaller than the one opposite to it, and is made flat on the side by the *trapezium*.—The exterior ridge is also smooth, and flat on its outside, for its conjunction with the *os scaphoideum*; immediately below which a semicircular smooth flat surface shews the articulation of this to the second metacarpal bone.—The back-part of this base is flattened, where the long head of the *extensor carpi radialis* is inserted; and the fore-part is prominent, where the tendon of the *flexor carpi radialis* is fixed.—The external side of the body of this bone is more hollowed for the action of muscles, than the internal.—The tubercle at the internal root of its head is larger than the external.—Its base is so firmly fixed to the bone it is connected with, that it has no motion.

The *metacarpus medii digiti* is generally the second in length; but often it is as long as the first; sometimes it is longer; and frequently it appears only to equal the first by the *os scaphoideum* being farther advanced downwards than any other bone of the wrist.—Its base is a broad superficial cavity, slanting outwards; the internal posterior angle of which is so prominent, as to have the appearance of a process.—The internal side of this base is made plain in the same way as the external side of the first bone, while its external side has two semicircular surfaces, for joining the third metacarpal bone, and between these surfaces there is a deep *fossa*, for the adhesion of a ligament, lodging mucilaginous glands.—The short-

er head of the *bicornis* is inserted into back-part of this base.—The two sides of bone are almost equally flattened; only the on the fore-part of the body inclines outwards.—The tubercles at the fore-part of the of the head are equal.—The motion of bone is very little more than the first metacarpal one has; and therefore these two firmly fist bodies pressed against them by the thumb or figures, or both.

*Os metacarpi digiti annularis* is shorter than the second metacarpal bone.—Its base is micircular and convex, for its conjunction with the *os unciforme*.—On its internal side two smooth convexities, and a middle fossa adapted to the second metacarpal bone.—The external side has a triangular smooth concave surface to join it with the fourth one. The anterior ridge of its body is situated more towards the out than to the in-side.—The tubercles at the head are equal.—The motion of this metacarpal bone is greater than the motion of the second.

*Os metacarpi minimi digiti* is the smallest and sharpest.—Its base is irregularly convex and rises slanting outwards.—Its internal side is exactly adapted to the third metacarpal bone. The external has no smooth surface, because it is not contiguous to any other bone; but is prominent where the *extensor carpi ulnaris* is inserted.—As this metacarpal bone is furnished with a proper moving muscle, has the plane of articulation, is most loosely connected and is not confined, it not only enjoys a much larger motion than any of the rest, but draws the third

it, when the palm of the hand is to be made hollow by its advancement forwards, and the prominence of the thumb opposite to

The *THUMB* and four *FINGERS* are each composed of three long bones.

The *Thumb* \* is situated obliquely in respect to the fingers, neither opposite directly to them, nor in the same plane with them. — All the bones are much thicker and stronger in proportion to their length, than the bones of the fingers are: Which was extremely necessary, since the thumb counteracts all the fingers.

The first bone of the thumb has its base attached to the double pulley of the *trapezium*. For, in viewing it from one side to the other, it appears convex in the middle; but when considered from behind forwards, it is concave there. — The edge at the fore-part of the base is produced farther than any other; and round the back-part of the base a deep *fossa* may be seen, for the connection of the ligaments of this joint. — The body and head of this bone are of the same shape as the *metacarpi*; only that the body is shorter, the head flatter, with the tubercles at the fore-part of its root larger.

The articulation of the upper end of this bone is uncommon: For though it has protuberances and depressions adapted to the double surface of the *trapezium*; yet it enjoys a circumflex motion, as the joints do where a round end of one bone plays in the orbicular socket

Z 2

of

Ἀντίχειρ, δίκονδυλός, *magnus digitus, promanus.*



of another; only it is somewhat more confident and less expeditious, but stronger and more secure, than such joints generally are.

This bone of children is in the same form with the metacarpal bones.

The second bone of the thumb has a large base formed into an oblong cavity, whose greatest length is from one side to the other.—Round it several tubercles may be removed, for the insertion of ligaments.—Its base is convex, or a half-round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is directed down by ligamentous sheaths that are fixed on each side to the pulley at the edge of this flat surface.—The lower end of this second bone has two lateral rounded protuberances, and a middle cavity, whose greatest extent of smooth surface is foreward.

The articulation and motion of the upper end of this second bone is as singular as that of the former.—For its cavity being joined to the rounded head of the first bone, it would seem in the first view to enjoy motion in all directions; yet, because of the strength of its lateral ligaments, oblong figure of the joint itself, and immobility of the first joint, it only allows of flexion and extension; and these are generally much confined.

The third bone of the thumb is the smallest, with a large base, whose greatest extent is from one side to the other.—This base is formed into two cavities and a middle protuberance, to be adapted to the pulley of the former bone.—Its body is rounded behind;



flatter than in the former bone, for sustaining the nail.—It is flat and rough before, by the insertion of the *flexor tertii internodii*.

—This bone becomes gradually smaller, till near the lower end, where it is a little enlarged, and has an oval scabrous edge.

The motion of this third bone is confined to flexion and extension.

The orderly disposition of the bones of the fingers into three rows, has made them generally obtain the name of three *phalanges* &c.

—All of them have half round convex surfaces, covered with an *aponeurosis*, formed by the tendons of the *extensors*, *lumbricales*, and *interossei*, and placed directly backwards, for their greater strength, and their flat concave part is forewards, for taking hold more firmly, and for lodging the tendons of the flexor muscles.—The ligaments for keeping down these tendons are fixed to the angles that are between the convex and concave surfaces.

The bones of the first *phalanx* \* of the fingers answer to the description of the second bone of the thumb: only that the cavity in their base is not so oblong; nor is their motion on the metacarpal bones so much confined: for they can be moved laterally or circumflexly, but have no rotation or a very small degree of it round their axis.

Both the ends of this first *phalanx* are in cartilaginous state at the birth; and the upper

Z 3

per

Seytalidæ, internodia, scuticula, agmina, acies, condyli.

Προκονδυλοί.

per one is afterwards affixed in form of an *epiphyse*.

The second bone \* of the fingers has its base formed into two lateral cavities, and a middle protuberance; while the lower end has two lateral protuberances and a middle cavity; therefore it is joined at both ends in the same manner, which none of the bones of the thumb are.

This bone is in the same condition with the former in children.

The third bone † differs nothing from the description of the third bone of the thumb excepting in the general distinguishing marks, and therefore the second and third phalanx of the fingers enjoy only flexion and extension.

The upper end of this third phalanx is cartilage in a ripe child; and is only an *epiphyse* after, till the full growth of the body.

All the difference of the phalanges of several fingers consists in their magnitude. The bones of the middle finger ‡ being the longest and largest, — those of the ring finger § come next to that in thickness, but not in length, for those of the ring-finger \*\* are a little longer. The little finger †† has the smallest.

\* Κονδυλοι.

† Μετακονδυλοι, ριζωνυχια.

‡ Κατακρυων, ορακκελος, infamis, impudicus, verpus, mosus, obscænus.

§ Δακτικος, indicator, λιχανος, demonstrativus, saluta-

\*\* Ιατρικος, παραμισος, δακτυλιωτης, επιβατης, annulus, medicus, cordis digiuis.

†† Μικρο, ωτιτης, auricularis, minimus,

smallest bones. Which disposition is the best contrivance for holding the largest bodies; because the longest fingers are applied to the middle largest periphery of such substances as are of a spherical figure (a).

The uses of all the parts of our *superior extremities* are so evident in the common actions of life, that it is needless to enumerate them here; and therefore I shall proceed to the last part of the skeleton. Only, lest I should seem to have forgot the small bones at the joints of the hand, I desire now to refer to the description of them, under the common title of *semitarsal bones*, which I have placed after the bones of the feet.

#### OF THE INFERIOR EXTREMITIES.

##### THE INFERIOR EXTREMITIES

depend from the *acetabula* of the *os iliacum*; are commonly divided into three parts, viz. the thigh, leg, and foot.

The *THIGH*\* has only one bone; which is the longest of the body, and the largest and longest of any of the cylindrical bones. The situation of it is not perpendicular: for the lower end is inclined considerably inwards; so that the knees are almost contiguous, while there is a considerable distance between the thigh-bones above: which is of good use to us, since sufficient space is thereby left for the external parts of

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(a) Galen de usu part. lib. 1. cap. 24.

Μηρὸν, femur, coxa, agis, anchæ os, crus, femur.

generation, the two great *cloaca* of urine and *faeces*, and for the large thick muscles that move the thigh inwards: and at the same time this situation of the thigh-bones renders our progression quicker, surer, straighter, and with less room; for had the knees been at a great distance from each other, we must have been obliged to describe some part of a circle with the trunk of our body in making a long step, and, when one leg was raised from the ground, our center of gravity would have been too far from the base of the other, and we should consequently have been in hazard of falling; that our steps would neither have been straight nor firm; nor would it have been possible to walk in a narrow path, had our thigh-bones been otherwise placed. In consequence, however, of the weight of the body bearing so obliquely on the joint of the knee, by this situation of the thigh-bones, weak, rickety children become in knee'd.

The upper end of the thigh-bone is continued in a straight line with the body of it, but is set off obliquely inwards and upwards, whereby the distance here between these two bones at their upper part is considerably increased.——This end is formed into a large smooth round head \*, which is the greater part of a sphere unequally divided.—Towards its lower internal part a round rough spongy process is observable, where the strong ligament, commonly, but unjustly, called the *round one*, is fixed, to be extended from thence to the lower

inter



internal part of the receiving cavity, where it is considerably broader than near to the head of the thigh-bone.——The small part below the head, called the *cervix*, of the *os femoris*, has a great many large holes into which the fibres of the strong ligament, continued from the capsular, enter, and are thereby surely united to it; and round the root of the neck, where it rises from the bone, a rough ridge is found, where the capsular ligament of the articulation itself is connected.——Below the back-part of this root, the large unequal prominence, called *trochanter major* †, stands out; the external convex part of which is distinguished into three different surfaces, whereof the one on the fore-part is scabrous and rough, for the insertion of the *gluteus minimus*; the superior one is smooth, and has the *gluteus medius* inserted into it; and the one behind is made flat and smooth by the tendon of the *gluteus maximus* passing over it.—The upper edge of this process is sharp and pointed on its back-part, where the *gluteus medius* is fixed; but forewards it is more obtuse, and has two superficial pits formed in it: Into the superior of these, the *piriformis* is implanted; and the *obturator internus* and *gemini* are fixed into the lower one.——From the backmost prominent part of this great *trochanter*, a rough ridge runs backwards and downwards, into which the *quadratus* is inserted.——In the deep hollow, at the internal upper side of this ridge, the *obturator externus* is implanted.——

More

† ΠΑΥΡΟΣ, rotator natis, malum granatum testiculorum.



More internally, a conoid process, called *trochanter minor* \*, rises for the insertion of the *musculus psoas*, and *iliacus internus*, and the *pectineus*, is implanted into a rough hollow below its internal root.—The muscles insert into these two processes being the principal instruments of the rotatory motion of the thigh have occasioned the name of *trochanters* to these processes.—The tendons that are fixed into or pass over the great *trochanter*, cause bruise by falls on this part to be attended with great pain and weakness of the limb, which generally remain long.

The body of the *os femoris* is convex on its fore-part, and made hollow behind, by the action of the muscles that move it and the leg, and for the conveniency of sitting, without bearing too much on these muscles; and probably the weight of the legs depends from the thighs in that posture contribute to this curvature.—The fore-part of the thigh-bone is a little flattened above by the beginning of the *crureus* muscle, as it is also below by the same muscle and the *rectus*.—Its external surface is likewise made flat below by the *vastus externus*, where it is separated from the former by an obtuse ridge.—The *vastus internus* depresses a little the lower part of the internal surface.—The posterior concave surface has a ridge rising in its middle commonly called *linea aspera*, into which the *triceps* is inserted; and the short head of the *biceps femoris* or *tibia* rises from it.—At the upper part of it the medullary vessels enter by a small hole.

\* Rotator minor.

at runs obliquely upwards.—A little above which there is a rough *fossa* or two, where the tendon of the *gluteus maximus* is fixed.—The lower end of the *linea aspera* divides into two, which descend towards each side.—The two *vasti* muscles have part of their origin from these ridges; and the long tendon of the *triceps* is fixed to the internal, by means of part of the *fascia aponeurotica* of the thigh.—Near the beginning of the internal ridge, there is a discontinuation of the ridge, where the crural artery passes through the *aponeurosis*. Between these two rough lines, the bone is made flat by the large blood-vessels and nerves which pass upon it; and near the end of each of these ridges, a small smooth protuberance may often be remarked, where the two heads of the external *gastrocnemius* muscle take their rise, and where sesamoid bones are sometimes found (*a*); and from the fore-part of the internal tubercle, a strong ligament is extended to the inside of the *tibia*.

The lower end of the *os femoris* is larger than any other part of it, and is formed into a great protuberance on each side, called its *condyles*; between which a considerable cavity is found, especially at the back-part, in which the crural vessels and nerves lie immersed in

—The internal condyle is longer than the external, which must happen from the oblique position of this bone, to give less obliquity to the leg.—Each of these processes seems to be divided in its plain smooth face. The mark of division on the external

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nal is a notch, and on the internal a small tubercle. The fore-part of this division, which the *rotula* moves, is formed like a pulley, the external side of which is highest. Behind, there are two oblong large heads, whose greatest extent is backwards, for the motion of the *tibia*; and from the rough cavity between them, but near to the base of the internal condyle, the strong ligament commonly called the *cross* one, has its rise. A little above which a rough protuberance gives insertion to the tendon of the *triceps*.—The condyles, both on the outer and inner side of the knee are made flat by the muscles passing along them.—On the back-part of the internal, a slight depression is made by the tendons of the *gracilis* and *sartorius*; and on the external such another is formed by the *ceps flexor cruris*; behind which a deep fossa is to be observed, where the *popliteus* muscle has its origin.—From the tubercle immediately before this cavity, a strong round ligament goes out to the upper part of the *fibula*.—Round this lower end of the thigh-bone, two holes are found, into which the ligaments for the security of the joint are fixed, and blood vessels pass to the internal substance of the bone.

All the processes of the *femur* are cartilaginous in new-born children, and afterwards become small *apophyses*, with large epiphyses.

The thigh-bone being articulated above with the *acetabulum* of the *ossa innominata*, which affords its round head a secure and extensive

can be moved to every side; but is restrained in its motion outwards, by the high rim of the cavity, and by the round ligament; for otherwise the head of the bone would have been frequently thrust out at the neck of the brims on the inside, which allows the thigh to move considerably inwards.

—The body of this bone enjoys little or no rotatory motion, though the head most commonly moves round its own axis; because the oblique progress of the neck and head of the bone is such, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor is this, as in the arm, ever capable of being brought to a straight direction with its body; but however as the head can move within the cavity backwards and forwards, the rest of the bone may have a partial rotation. — When the thigh-bone resists the actions of the muscles more than the trunk of the body then do, as in standing, these muscles have no effect on the trunk, causing it to bend forwards, raising it up, inclining it to the one or the other side, twisting it obliquely, &c. which rolling of the *acetabula* of the *os innominatum* on the round heads of the thigh-bones is well fitted for. — The *os femoris* is articulated below to the *tibia* and *rotula* in the manner afterwards to be described.

The nearness of the small neck to the round head of the thigh-bone, and its upper end being covered with very thick muscles, make it rather difficult in distinguishing between a

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luxation



luxation and fracture here, than in any part of the body.

The *LEG* \* is composed, according to common account, of two bones, *tibia* and *fibula*, though it seems to have a very good analogy to a third, the *rotula*; which bears a strong analogy to the *olecranon* of the *ulna*, and moves always with the other two.

*TIBIA* †, so called from its resemblance to an old musical pipe or flute, is the long triangular bone, situated at the internal part of the leg, and continued in almost a straight line from the thigh-bone.

The upper end of the *tibia* is large, bony, and spongy, and is divided into two cavities, by a rough irregular protuberance which is hollow at its most prominent part as well as before and behind. The anterior of the two ligaments that compose the *crus* one, is inserted into the middle of the cavity, and the depression behind receives the posterior ligament.——The two broad ligaments at the sides of this protuberance are of equal size; for the internal is oblong and is to receive the internal *condyle* of the *femur* bone; while the external is more superficial and rounder, for the external *condyle*.——In each of these two cavities of a recent subject, a semilunar cartilage is placed, which is thick at its convex edge, and becomes

\* *Κνήμη*, *crus*, *tibia*.

† *Προκνήμιον*, *ὀντικνήμιον*, *fecile majus*, *arundinacea*, *canna major*, *canna domestica* *cruris*.

‡ *Διαρυσίς*, *ἐξοχή* *νευροχονκρῶδης*, *tuber*, *tuberculum*.



ally thinner towards the concave or interior  
 —The middle of each of these car-  
 ages is broad, and the ends of them turn  
 grower and thinner, as they approach the  
 dle protuberance of the *tibia*. —The  
 ck convex edge of each cartilage is con-  
 ted to the capsular and other ligaments of  
 articulation, but so near to their rise from  
*tibia*, that the cartilages are not allowed  
 change place far; while the narrow ends  
 the cartilages becoming almost ligaments,  
 fixed at the insertion of the strong cross  
 ment into the *tibia*, and seem to have their  
 stance united with it; therefore a circular  
 is left between each cartilage and the li-  
 ment, in which the most prominent convex  
 of each condyle of the thigh-bone moves.  
 —The circumference of these cavities is  
 gh and unequal for the firm connection  
 the ligaments of the joint. —Immedi-  
 ly below the edge at its back-part, two  
 gh flattened protuberances stand out: Into the  
 rnal, the tendon of the *semimembranosus*  
 cle is inserted; and a part of the cross li-  
 ment is fixed to the external. —On the  
 side of this last tubercle, a smooth slightly-  
 lowed surface is formed by the action of the  
*gluteus* muscle.  
 Below the fore part of the upper end of  
*tibia*, a considerable rough protuberance  
 rises, to which the strong tendinous liga-  
 ment of the *rotula* is fixed. —On the internal  
 of this, there is a broad scabrous slightly-

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hollowed

hollowed surface, to which the internal ligament of the joint, the *aponeurosis* of *vastus internus*, and the tendons of the *semitendinosus*, *gracilis*, and *sartorius*, are fixed. The lowest part of this surface is therefore the place where the *tibia* ought to be sawed in an amputation, so as not to have too long and troublesome a stump, and, at the same time, to preserve its motions, by saving the *peroneus* muscles. — Below the external edge of the upper end of the *tibia*, there is a circular flat surface, covered in a recent subject with cartilage, for the articulation of the *femur* — between which and the anterior knuckle there is a rough hollow from which the *tibialis anticus*, and *extensor digitorum longus*, take their origin. — From the smooth flat surface, a ridge runs obliquely downwards inwards, to give rise to part of the *soleus*, *tibialis posticus*, and *flexor digitorum longus*, and to give insertion to the *aponeurosis* of the *semimembranosus* which covers the *popliteus*, and to form the external fibres of this last named muscle. — At the inside of this ridge an oblique plain surface is left, where the greatest part of the *musculus popliteus* is inserted. — The remaining body of the *tibia* is triangular. The anterior angle is very sharp, and is commonly called the *spine* or *shin* †. This is not straight; but turns first inwards, then outwards, and lastly inwards again. — The plain internal side is smooth and equal, but little subjected to the actions of muscles;

† Ακνῆς, spina, creta, linea prima tibiae, angulus acutus

external side is hollowed above by the *malis anticus*, and below by the *extensor digitorum longus* and *extensor pollicis longus*.

—The two angles behind these sides are rounded by the action of the muscles;—the posterior side comprehended between them is so broad as those already mentioned, but is more oblique and flatted by the action of the *malis posticus* and *flexor digitorum longus*.—Some way above the middle of the bone, the external angle terminates, and the bone is made round by the pressure of the *musculus*.—Near to this, the passage of the medullary vessels is seen slanting obliquely downwards.

The lower end of the *tibia* is made hollow, so as a small protuberance rises in the middle.——The internal side of this cavity, which is smooth, and, in a recent subject, covered with cartilage, is produced into a considerable process, commonly named *malleolus internus* \*; the point of which is divided by a notch, and from it ligaments are sent out to the foot.——We ought to observe, that this internal *malleolus* is situated more forewards than the internal condyle of the upper end of this bone; which is necessary to be remembered in reducing a fracture of the leg (a).——The external side of this end of the *tibia* has a rough irregular semilunar cavity.

A a 3. vity

ἑρπον, πτερον, talus, clavicle, clavilla interior, clavilla do-

Winflow, Exposition anatomique, des os secs, sect.

vity formed in it, for receiving the lower end of the *fibula*.— The posterior side has two lateral grooves, and a small middle protuberance. In the internal depression, the tendons of the *musculus tibialis posticus* and *flexor digitorum longus* are lodged; and in the external, the tendon of the *flexor longus pollicis* plays.—From the middle protuberance, ligamentous sheaths go out, for tying down the tendons.

The articulations and motions of the *tibia* shall be explained, after all the three bones of the leg are described.

Both the ends of the *tibia* are cartilaginous at birth, and become afterwards epiphyses.

*FIBULA*\* is the small long bone, placed on the outside of the leg, opposite to the internal angle of the *tibia*; the shape of it is regularly triangular.

The head of the *fibula* has a superficial circular cavity formed on its inside, which, in recent subject, is covered with a cartilage, so closely connected to the *tibia* by ligaments as to allow only a small motion backwards and forwards.—This head is protuberant and rough on its outside, where a strong round ligament and the *musculus biceps* are inserted; and, below the back-part of its internal surface, a tubercle may be remarked, that gives origin to the strong tendinous part of the *soleus* muscle.

\* Παράκνημιον, perone, fœcile minus, arundo minor, minor cruris, fura, radius.

The body of this bone is a little crooked forwards and backwards, which figure is owing to the actions of the muscles; but is still further increased by nurses, who often hold children carelessly by the legs. — The sharpest angle of the *fibula* is forewards, on each side of which the bone is considerably but unequally depressed by the bellies of the several muscles that rise from, or act upon it; and, in old people, these muscles make distinct sinuosities for themselves. — The external surface of the *fibula* is depressed obliquely from above downwards and backwards, by the two *peronæi*. — Its internal surface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament stretched between the two bones of the leg is connected. — The anterior of the two planes is very narrow above, where the *extensor longus digitorum* and *extensor longus pollicis* arise from it; but is broader below, where it has the print of the *nonas Vesalii*. — The posterior plane is broad and hollow, giving origin to the larger share of the *tibialis posticus*. — The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the *flexor digitorum longus* take their rise. — The posterior surface of the *fibula* is the plainest and smoothest, but is made flat above by the *solæus*, and is hollowed below by the *flexor pollicis longus*. — In the middle of this



this surface the canal for the medullary vessels may be seen slanting downwards.

I have taken particular notice of the entry and direction of the medullary vessels of the large bones of the extremities (a); because, in several chirurgical cases, a surgeon who is ignorant of this, may do mischief to his patient. Thus, for example, if these vessels are opened very near to their entry into the bone, or while they are in the oblique passage though it, an obstinate hæmorrhagy may ensue: For the arteries being connected to the bony passage, styptics, and other like constrictors, are vainly applied; compressing instruments can do no service, and ligatures cannot be employed.—There seems to be a particular design in the contrivance of these canals; those in the *os humeri*, *tibia*, and *fibula*, running obliquely downwards from their external entry; whereas in the *radius*, *ulna*, and *os femoris*, they slant upwards, where the arteries and nerves which are sent into these three last bones, must suffer a considerable reflection before they come at the cancelli. The reason of this diversity may perhaps be that the arteries which are so small within the bones as to have no strong contractile propelling force in their coats, and where they are not assisted by the action of any moving neighbouring organ, should have, at least in the passage through the bone, a favourable descent for their liquids: Which, it is evident, they have in the descending oblique passages formed for them in the first class of bones, to wit,

(a) Havers, Osteolog. nov. disc. 1. p. 59.

of *humeri*, *tibia*, and *fibula*, which are generally depending; and they also most frequently acquire the like advantage in the *radius*, *ulna*, and *os femoris*, because the hand, in the most natural posture, is higher than the elbow; and when we sit or lie, the lower end of the thigh-bone comes to be at least as high raised as the upper. In standing and walking, or when the arms are moved, the blood must indeed ascend as it passes through the bones of the fore-arm and thigh; but the pressure of the muscles, then in action, on the vessels, before they enter the bones, is sufficient to compensate the disadvantage of their course. This reasoning seems to be still enforced, by observing, that this passage is always nearer the upper than the lower ends of these bones.

The lower end of the *fibula* is extended into a spongy oblong head, on the inside of which is a convex, irregular, and frequently scabrous surface, that is received by the external hollow of the *tibia*, and so firmly joined to it by a very thin intermediate cartilage and strong ligaments, that it scarce can move.—Below this, the *fibula* is stretched out into a coronoid process, that is smooth, covered with cartilage on its internal side, and is there contiguous to the outside of the first bone of the foot, the *astragalus*, to secure the articulation. This process, named *malleolus externus*, being situated farther back than the internal *malleolus*, and in an oblique direction, obliges the foot naturally to turn the fore-part of the foot outwards.

outwards (a). At the lower internal part of this process, a spongy cavity for mucilaginous glands may be remarked; from its point ligaments are extended to the *astragalus*, *calcis*, and *os naviculare*, bones of the foot; and from its inside short strong ones go out to the *astragalus*. On the back-part of it a sinuosity is made by the tendons of the *peronei* muscles.—When the ligament extended over these tendons from the one side of the depression to the other is broke, stretched too much, or made weak by a sprain, the tendons frequently start forwards to the outside of the *fibula*.

The conjunction of the upper end of the *fibula* with the *tibia* is by plain surfaces tipped with cartilage, and at its lower end the cartilage seems to glue the two bones together, not, however, so firmly in young people, but that the motion at the other end of such a long *radius* is very observeable.—In old subjects I often see the two bones of the leg grow together at their lower ends.

The principal use of this bone is to afford origin and insertion to muscles; the direction of which may be a little altered on proper occasions, by its upper part shuffling backwards and forwards.—It likewise helps to make the articulation of the foot more secure and firm.—The ends of the *tibia* and *fibula* being larger than their middle, a space is here left which is filled up with such another ligament as I described extended between the bones

(a) Winslow, Memoires de l'acad. des sciences, 1723.

the fore-arm; and which is also discontinued at its upper part, where the *tibialis anticus* immediately adheres to the *soleus* and *tibialis posticus*; but every where else it gives origin to muscular fibres (a).

Both the ends of this bone are cartilaginous in a ripe child, and assume the form of appendices before they are united to its body.

**ROTULA** † is the small flat bone situated at the fore-part of the joint of the knee.—Its shape resembles the common figure of the heart with its point downwards.—The anterior convex surface of the *rotula* is pierced by a great number of holes, into which fibres of the strong ligament that is spread over it enter.—Behind, its surface is smooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largest; and both are exactly adapted to the pulley of the *os femoris*, on which they are placed in the most ordinary unstraining postures of the leg; but when the leg is much extended, the *rotula* descends far down on the condyles; and when the leg is fully extended, the *rotula* rises higher, in its upper part, than the pulley of the thigh-bone.—The plain smooth surface is surrounded by a rough prominent edge, to which the capsular ligament adheres:—Below, the point of the bone is scartious, where the strong tendinous ligament from the tubercle of the *tibia* is fixed.—The upper

(a) Weitbrecht, Syndesmolog. p. 156.

Ἐπιμυλις, μυλακρίς, κόγχος, ἐπιγονατὶς, πλανησιεδρον  
mela, mola, genu, icu i forme os, cartilaginofum, difci-  
me, oculus genu.



upper horizontal part of this bone is flattened and unequal, where the tendons of the extensors of the leg are inserted.

The substance of the *rotula* is cellular, with very thin external firm plates : But then the *cells* are so small, and such a quantity of bone is employed in their formation, that scarce any bone of its bulk is so strong. Besides, it is covered all over with a thick ligament, (as it was observed, that this sort of bones generally is to connect its substance, and is moveable on one side or other; therefore is sufficiently strong to resist the ordinary actions of the large muscles that are inserted into it, or any common external force applied to it; while a fixed process, such as the *olecranon*, would not have been sufficient to bear the whole weight of the bodies, which frequently falls on it, and would have hindered the rotatory motion of the bone. Notwithstanding these precautions to preserve this bone from such injuries; yet I have seen a transverse fracture in it, when, by the report of the patient, and of the people about him, and by the want of swelling, discolouring, or other mark of bruise or contusion, it was plain that the bone was broken by the violent strain and effort of the muscles (a). Though my patient recovered the use of the joint of the knee, yet I think it reasonable to believe, that this sort of fracture is commonly attended with a difficulty of motion, after the broken parts of the *rotula* are reunited; because the callous matter probably extends itself into the cavity of the joint, where it either grows to some

(a) See Ruysch, *Observ. anat. chirurg. obs.* 3.



the parts or makes such an inequality on the surface of this bone, as does not allow it to perform the necessary motions on the condyles of the *femur* (a).

At the ordinary time of birth, the *rotula* is entirely cartilaginous, and scarcely assumes a bony nature so soon as most *epiphyses* do.

The parts which constitute the joint of the knee being now described, let us examine what are its motions, and how performed.—The two principal motions are flexion and extension.—In the former of these, the leg may be brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made smooth far backwards. In performing this, the *rotula* is pulled down to the *tibia*.—When the leg is to be extended, the *rotula* is drawn upwards, consequently the *tibia* forewards, by the *extensor* muscles; which, by means of the protuberant joint, and this thick bone with its ligament, have in effect the chord, with which they act, fixed to the *tibia* at a considerable angle, therefore act with advantage; but are restrained from pulling the leg farther than to a straight line with the thigh, by the posterior part of the *cross* ligament, that the body might be supported by a perpendicular column: For at this time the thigh and leg are as little moveable in a rotatory way, or to either side, as if they were continued bone.—But when the joint is a little bended, the *rotula* is not tightly braced, and the posterior ligament is relaxed; therefore this bone may be moved a little to either side, or with a small rotation in the superficial

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cavities

cavities of the *tibia*; which is done by the motion of the external cavity backwards and forwards, the internal serving as a sort of axis. Seeing then one part of the *cross* ligament situated perpendicularly, and the posterior part is stretched obliquely from the internal condyle of the thigh outwards, that posterior part of the *cross* ligament prevents the leg's being turned at all inwards; but it could not hinder it from turning outwards almost round, was that motion confined by the lateral ligaments of this joint, which can yield little. This rotation of the leg outwards is of good advantage to us in crossing our legs, and turning our feet outwards, on several necessary occasions; and it is altogether fit this motion should not be very large, to prevent frequent luxations.

While all these motions are performed, the part of the *tibia* that moves immediately on the condyles is only so much as is within the cartilaginous rings, which, by their softness on their outsides, make the cavities of the *tibia* more horizontal, by raising their internal side where the surface of the *tibia* lies downwards. By this means the motions of this joint are more equal and steady than otherwise they would have been. The cartilages being capable of changing a little their situation, are fit for doing this good office in different motions and postures of the member, and likewise contribute to make the motions larger and quicker.

On account of the very large surface of the bones forming the joint of the knee, and

(4) Winslow, Exposition anatomique du corps humain, des os fcees, § 976.

many strong ligaments connecting them, luxations seldom happen here. But these very ligaments, the *aponeurosis* passing over this joint, the quantity of fat and mucilaginous glands necessary for lubricating it, make it more subject to *white-swellings*, dropsies, and such other disorders, than any other joint of the body.

The *FOOT* is divided, as well as the hand, into three parts, *viz.* *tarsus*, *metatarsus*, and *phalanges*: In the description of which, the several surfaces shall be named, according to their natural situation, *viz.* the *broad* of the foot, shall be called superior; the sole, inferior; the side on which the great toe is, internal; that where the little toe is, external.

The *tarsus* † consists of seven spongy bones; *viz.* the *astragalus*, *os calcis*, *naviculare*, *cuboides*, *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

The *astragalus* is the uppermost of these bones.—The *os calcis* is below the *astragalus*, and is considerably prominent backwards beyond the other bones to form the heel.

—The *os naviculare* is in the middle of the internal side of the *tarsus*.—The *os cuboides* is the most external of the row of four bones at its fore part.—The *os cuneiforme externum* is placed at the inside of the *cuboid*.—The *cuneiforme medium* is between the *external* and *internal cuneiform* bones, and the *internal cuneiform* is put at the internal side of the foot.

That the description of these bones may not be

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be immoderately swelled with repetition, I direct, once for all, to observe, That where a ridge is mentioned, without a particular assignment, a ligament is understood to be fixed to it: or where a spongy rough cavity, depression, or *fossa* is remarked, without naming its use, a ligament is inserted, and mucilaginous glands are lodged: For such will occur the detail of each of these bones.

The upper part of the *astragalus* † is formed into a large smooth head ‡, which is slightly hollowed in the middle; and therefore resembles a superficial pulley, by which it is fixed to the lower end of the *tibia*.—The internal side of this head is flat and smooth, to play on the internal *malleolus*.—The external side has also such a surface, but larger, for its articulation with the external *malleolus*.—Round the base of this head there is a rough *fossa*, and, immediately before the head, as also along its internal smooth surface, we find a considerable rough cavity.

The lower surface of the *astragalus* is divided by an irregular deep rough *fossa*; which at its internal end is narrow, but gradually widens, as it stretches obliquely outwards and forwards.—The smooth surface, covered with cartilage, behind this *fossa*, is large, oblong, extended in the same oblique situation with the *fossa*, and concave, for its conjunction with the *calcis*.—The back part of the edge of this cavity is produced into two sharp pointed processes.

† *Ἀστράγος*, talus, balistæ os, malleolus, chaib, quadrifidæ, tessellæ, clavicular, nuciforme,

‡ *Ἐνδοστέον*.



processes, between which is a depression made by the tendon of the *flexor pollicis longus*.—The lower surface before the *fossa* is convex, and composed of three distinct smooth planes. The long one behind, and the exterior or short-ell, are articulated with the heel-bone; while the internal, which is the most convex of the three, rests and moves upon a cartilaginous ligament, that is continued from the *calcaneum* to the *os scaphoides*. Without which ligament, the *astragalus* could not be sustained, but would be pressed out of its place by the great weight it supports, and the other bones of the *tarsus* would be separated. Nor would a bone be fit here, because it must have been thicker than could conveniently be allowed; otherwise it would break, and would not prove such an easy bending base, to lessen the shock which is given the body in leaping, running, &c.

The fore-part of this bone is formed into a convex oblong smooth head, called by some process, which is received by the *os naviculare*.—Round the root of this head, especially on the upper surface, a rough *fossa* may be marked.

The *astragalus* is articulated above to the *tibia* and *fibula*, which together form one cavity. Though, in this articulation, the bones have prominencies and cavities so small, as might allow motions in all directions; yet the flexion and extension are the most considerable, the other motions being confined by the *malleoli*, and by the strong ligaments which go out from the points of these processes to the *astragalus* and *os calcis*.—When the foot is bended, so far



as it is commonly when we stand, no lateral or rotatory motion is allowed in this joint; for then the head of the *astragalus* is sunk deep between the *malleoli*, and the ligaments are tense; but when the foot is extended, the *astragalus* can move a little to either side, and with a small rotation. By this contrivance the foot is firm, when the weight of the body is to be supported on it; and when a foot is raised, we are at liberty to direct it more exactly to the place we intend next to step upon. The *astragalus* is joined below, to the *os calcis*; and before, to the *os naviculare*, in the manner to be explained, when these bones are described.

A considerable share of this bone is ossified in a new born infant.

*Calcaneum* \* is the largest bone of the foot. Behind, it is formed into a large knob commonly called the *heel*: The surface of which is rough behind, where the *tendo Achillis* is inserted into it; and above, it is hollow and spongy. Farther forwards, on the upper surface of the *calcaneum*, there is an irregular oblong smooth convexity, adapted to the concavity at the back-part of the *astragalus*: And beyond this a narrow *fossa* is seen, which divides it into two small concave smooth surfaces, that are joined to the fore-part of the *astragalus*. Behind the posterior of these smooth surfaces, which is the largest, a small sinuosity is made for the tendon of the *flexor digitorum longus*, at the fore-part of which a small rough

tubercle

\* *Os calcis*, πτερίς, calcar pedis.

tubercle appears, that gives rise to the *musculus extensor digitorum brevis*.

The external side of this bone is flat, with a superficial *fossa* running horizontally, in which the tendon of the *musculus peroneus longus* is lodged.——The internal side of the heel bone is hollowed, for lodging the origin of the *massa cornea Jac. Sylvii*, and for the safe passage of tendons, nerves, and arteries.——Under the side of the internal smooth concavity, a particular groove is made by the tendon of the *flexor pollicis longus*; and from the thin protuberance on this internal side, the cartilaginous ligament that supports the *astragalus*, goes out to the *os naviculare*; on which ligament, and on the edge of this bone to which it is fixed, the groove is formed for the tendon of the *flexor digitorum profundus*.

The lower surface of this bone is pressed flat at the back part, by the weight of our bodies; and immediately before this plane, there are two tubercles, from the internal of which the *musculus abductor pollicis*, *flexor digitorum sublimis*, as also part of the *aponeurosis plantaris*, and of the *abductor minimi digiti*, have their origin; and the other part of the *abductor minimi digiti* and *aponeurosis plantaris* rises from the external.——Before these protuberances this bone is concave, for lodging the flexor muscles; and at its fore-part we may observe a rough depression, from which, and a tubercle behind it, the ligament goes out that prevents this bone to be separated from the *os cuboides*.

The fore-part of the *os calcis* is formed into an oblong pulley-like smooth surface, which is circular

circular at its upper external end, but is pointed below. This smooth surface is fitted to the *os cuboides*.

Though the surfaces by which the *astragalus* and *os calcis* are articulated, seem fit enough for motion; yet the very strong ligaments by which these bones are connected, prevent it, and render this principal part of our base, which rests on the ground, *to wit*, the *os calcis* firm.

A large share of the heel-bone is ossified at the ordinary time of birth, and the large knob appears afterwards in form of an epiphysse.

*Os naviculare* \*, is somewhat circular.—It is formed into an oblong concavity behind for receiving the anterior head of the *astragalus*.—On the upper surface there is a rough *fossa*.—Below, the *os naviculare* is very unequal and rough; but hollow for the safety of the muscles.—On its inferior a large knob rises out, from which the *abductor pollicis* takes in part its origin, the tendon of the *tibialis posticus* is inserted into it, and to it two remarkable ligaments are fixed; the first is the strong one formerly mentioned, which supports the *astragalus*; the second is stretched from the bone obliquely across the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one.—On the outer side of the *os naviculare* there is a semicircular smooth surface, where it is joined to the *os cuboides*.—The fore part of this bone is a

covered

\* *Σκαφοειδής*, *os cymbæ*.

covered with cartilage, and is divided into three smooth planes, fitted to the three *ossa cuneiformia*.

The *os naviculare* and *astragalus* are joined as a ball and socket, and the *naviculare* moves in all directions in turning the toes inwards, or in raising or depressing either side of the foot, though the motions are greatly restrained by the ligaments which connect this to the other bones of the *tarsus*.—A weakness of these ligaments causes sometimes an unnatural turn of the fore-part of the foot inwards.

The *os naviculare* is wholly cartilaginous in a new-born infant.

*OS CUBOIDES* \* is a very irregular cube.—Behind, it is formed into an oblong unequal concavity, adapted to the fore-part of the *os calcis*.—On its internal side, there is a small semicircular smooth cavity, to join the *os naviculare*.—Immediately before which, an oblong smooth plane is made by the *os cubiforme externum*.—Below this the bone is hollow and rough.—On the internal side of the lower surface, a round protuberance and *fossa* are found, where the *musculus adductor hallucis* has its origin. On the external side of this same surface, there is a round knob, covered with cartilage; immediately before which, a smooth *fossa* may be observed, in which the tendon of the *peroneus primus* runs obliquely across the foot; and on the knob, the thin flat cartilage

\* Πυλωμορφον, cubiforme, quadratum, grandinosum, varium,   
 Lrac, multiforme.



cartilage proper to this muscle plays ; in place of which sometimes a bone is found :—More externally than the knob, a rough hollow made, for the strong ligaments stretched betwixt this bone and the *os calcis*.—Before the surface of the *os cuboides* is flat, smooth and slightly divided into two planes, for sustaining the *os metatarsi* of the little toe, and of the toe next to it.

The form of the back-part of the *os cuboides* and the ligaments connecting the joint thereof with the *os calcis*, both concur in allowing little motion in this part.

The ossification of this bone is scarcely begun at the birth.

*Os cuneiforme externum* \*, if we regard its situation or *medium* by its bulk, is much of the shape of a wedge, being broad and flat above with long sides running obliquely downward and terminating in a sharp edge.——The upper surface of this bone is an oblong square.——The one behind is nearly a triangle, but not complet at the inferior angle, and is joined to the *os naviculare*.——The external side is an oblong square divided as it were by a diagonal ; the upper half of it is smooth, for its conjunction with the *os cuboides* : The other is a scabrous hollow, and in its superior anterior angle a small smooth impression is made by the *os metatarsi* of the toe next to the little one. The internal side of this bone is also quadrangular, with the fore-part of its edge made flat and smooth by the *os metatarsi* of the toe next

\* *Chalcoideum externum*.



to the great one, and the back-part is also flat and smooth where the *os cuneiforme medium* is contiguous to it.—The fore-part of this bone is an oblong triangle, for sustaining the *os metatarsi* of the middle toe.

*Os cuneiforme medium*, or *minimum*, is still more exactly the shape of a wedge than the former.—Its upper part is square ;—its internal side has a flat smooth surface above and behind, for its conjunction with the following bone ; with a small rough *fossa* below ; and a considerable share of it is rough and hollow.—The external side is smooth and a little hollowed, where it is contiguous to the last described bone.—Behind, this bone is triangular, where it is articulated with the *os naviculare* ; and it is also triangular at its fore-part, where it is contiguous to the *os metatarsi* of the toe next the great one.

*Os cuneiforme maximum* or *internum*, differs from the two former in its situation, which is more oblique than theirs.—Besides, its broad back part is placed below, and the small thin point is above and outwards ; while its under broad surface is concave, for allowing a safe passage to the flexors of the great toe.—The surface of this *os cuneiforme* behind, where it is joined to the *os naviculare*, is hollow, smooth, and of a circular figure below, but pointed above.—The external side consists of two smooth and flat surfaces, whose direction is nearly at right angles with each other. With the posterior, that runs obliquely from below forwards and upwards, the *os cuneiforme minimum* is joined ; and with the anterior, whose direction is longitudinal,

longitudinal, the *os metatarsi* of the toe next to the great one is connected.——The fore part of this bone is semilunar, but flat and smooth, for sustaining the *os metatarsi* of the great toe.——The internal side is scabrous with two remarkable tubercles below, from which the *musculus abductor pollicis* rises, and the *tibialis anticus* is inserted into its upper part.

The three cuneiform bones are all so secured by ligaments, that very little motion is allowed in any of them, and they are cartilaginous in a *fœtus* of nine months.

These seven bones of the *tarsus*, when joined, are convex above, and leave a concavity below, for lodging safely the several muscles, tendons, vessels, and nerves that lie in the sole of the foot.—In the recent subject, their upper and lower surfaces are covered with strong ligaments which adhere firmly to them, and all the bones are so tightly connected by these and other ligaments, which are fixed to the root of the ridges and *fossæ* mentioned in the preceding description of the particular bones, that, notwithstanding the many surfaces covered with cartilage, some of which are of the form of the very moveable articulations, no more motion is here allowed, than only to prevent to the great a shock of the fabric of the body in walking, leaping, &c. by falling on too solid a base, which, if it was one continued bone, would likewise be much more liable to be broken: and, in order to make our foot accommodate itself to the surfaces we tread on, by becoming more or less hollow, or by raising or depressing either

side of it, as might be judged by what was said of the particular bones.

Sprains here occasion, as in the wrist, great pain and obstinate tumours, which too often cause carious bones.

*METATARSUS* \* is composed of five bones, which, in their general characters, agree with the metacarpal bones; but may be distinguished from them by the following marks: 1. They are longer, thicker, and stronger. 2. Their anterior round ends are not so broad, and are less in proportion to their bases. 3. Their bodies are sharper above and flatter on the sides, with their inferior edge inclined more to the outside. 4. The tubercles at the lower parts of the round head are larger.

The first or internal metatarsal bone is easily distinguished from the rest by its thickness. The one next to it is the longest, and with a sharp edge almost perpendicular.—The others are shorter and more oblique, as their situation is more external. Which general remarks, with the description I am now to give of each, may teach us to distinguish them from each other.

*Os metatarsi pollicis* is by far the thickest and longest, as having much the greatest weight to sustain. Its base is oblong, irregularly convex, and of a semilunar figure, to be adapted to the *os cuneiforme maximum*.—The inferior edge of this base is a little prominent and

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rough,

*ῥίζα, ῥίζιον, planta, planum, vestigium, solium, pectus, pedum, pectusculum.*

rough, where the tendon of the *peroneus profundus* muscle is inserted.—On its outside an oblique circular depression is made by the second metatarsal bone.—Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the *ossa sesamoidea*; and on the external side a depression is made by the following bone.

*Os metatarsi* of the second toe, is the longest of the five, with a triangular base supported by the *os cuneiforme medium* and the external side produced into a process; the end of which is an oblique smooth plane, joined to the *os cuneiforme externum*.—Near the internal edge of the base, this bone has two small depressions, made by the *os cuneiforme maximum*, between which is a rough cavity.—Farther forwards we may observe a smooth protuberance, which is joined to the foregoing bone.—On the outside of the base are two oblong smooth surfaces, for its articulation with the following bone; the superior smooth surface being extended longitudinally and the inferior perpendicularly; between which there is a rough *fossa*.

*Os metatarsi* of the middle toe, is the second in length.—Its base, supported by the *os cuneiforme externum*, is triangular, but sloping outwards, where it ends in a sharp-pointed little process; and the angle below is not completed.

The internal side of this base is adapted to the preceding bone; and the external side has also two smooth surfaces covered with cartilage, but of a different figure; for the



per one is concave, and, being round behind, turns smaller as it advances forwards; and the lower surface is little, smooth, convex, and very near the edge of the base.

*Os metatarsi* of the fourth toe, is near as long as the former, with a triangular slanting base joined to the *os cuboides*, and made round at its external angle, having one hollow smooth surface on the outside, where it is pressed upon by the following bone, and two on the internal side, corresponding to the former bone; behind which is a long narrow surface impressed by the *os cuneiforme externum*.

*Os metatarsi* of the little toe, is the shortest, situated with its two flat sides above and below, and with the ridges laterally.——The base of it, part of which rests on the *os cuboides*, is very large, tuberos, and produced into a long-pointed process externally, where part of the *ductor minimi digiti* is fixed; and into its upper part the *peroneus secundus* is inserted.——Its inside has a flat conoidal surface, where it is contiguous to the preceeding bone.

When we stand, the fore-ends of these metatarsal bones, and the *os calcis*, are our only supporters; and therefore it is necessary they should be strong, and should have a confined motion.

The bones of the *TOES* are much a-kin to those of the thumb and fingers; particularly the two of the great toe are precisely formed as the two last of the thumb; only their position, in respect of the other toes, is not oblique; and they are proportionally much longer, because they are subjected to a greater



force; for they sustain the force with which our bodies are pushed forwards by the foot behind at every step we make; and on the principally the weight of the body is supported, when we are raised on our tiptoes.

The three bones in each of the other four toes, compared to those of the fingers, differ from them in these particulars. — They are less, and smaller in proportion to their length — — Their bases are much larger than the anterior ends: Their bodies are more narrow above and below, and flatter on the sides — The first *phalanx* is proportionally much longer than the bones of the second and third which are very short.

Of the four, the toe next to the great one has the largest bones in all dimensions, and more externally the toes are less. — The little toe, and frequently that next to it, has the second and third bones intimately united into one; which may be owing to their little motion, and the great pressure they are subjected to.

The toes are of good use to us in walking for, when the sole is raised, they bring the body, with its center of gravity, perpendicular to the advanced foot.

The bones of the *metatarsus* and toes, are in the same condition in children as those of the *metacarpus* and fingers.

The only bones now remaining to complete the description of the skeleton, are the small ones, which are found at the joints of the fingers and toes, and in some other parts, called

*OSSA SESAMOIDEA*, which are of very different figures and sizes, though they are generally said to resemble the seed of the *sesamum*.—They seem to me nothing else than the ligaments of the articulations or the firm tendons of strong muscles, or both, become bony, by the compression which they suffer. Thus the *sesamoid* bones at the beginning of the *gastrocnemii* muscles, are evidently composed of the tendinous fibres only.—These, at the first joint of the great toe, are as plainly the same continued substance with the ligaments and the tendons of the *adductor*, *flexor*, *brevis*, and *abductor*.—That which is sometimes double at the second joint of that toe, is part of the capsular ligament; and if we enumerate the other *sesamoid* bones that are at any time found, we may observe all of them formed in this manner.—Their number, figure, situation, and magnitude, are so uncertain, that it were in vain to insist on the differences of each; and therefore I shall only in general remark,

1. That where ever the tendons and ligaments are firmest, the actions of the muscles strongest, and the compression greatest, there such bones are most commonly found.
2. That, *ceteris paribus*, the older the subject is in which they are sought, their number greater, and their size is larger.
3. The more labour any person is inured to, he has, *ceteris paribus*, the most numerous and largest *ossa sesamoidea*.

However, as the two at the first joint of the great toe are much larger than any other, are

early formed, and are seldom wanting in an adult, we may judge, that besides the most forcible cause of their formation, there should also be some particular advantage necessary in this place, rather than elsewhere, which may possibly be, to allow the *flexor* muscles to secure their tendons along this joint, secure from compression in the hollow between the two long sesamoid bones; while, by removing the tendons from the center of motion, and giving them the advantage of an angle at the insertion, the force of the muscles is increased, and therefore the great superincumbent weight of our body in progression is more easily raised.

A P P E

## A P P E N D I X.

### Of the Marks of a FEMALE SKELETON.

TO finish the description of the bones, is generally to conclude the *osteology*; but that no part of the subject may be left untouched, I think it necessary to subjoin the distinguishing marks of the male and female skeletons; and have chosen to illustrate them principally in the latter; because women having a more delicate constitution, and affording less food and nourishment to their tender *fœtus*, till they have sufficient strength and firmness to bear the injuries of the atmosphere, and contact of other more solid substances, their bones are frequently incomplete, and always of a make in some parts of the body different from those of the robust male; which agree to the description already given, unless where the proper specialities of the female were particularly remarked; which could not be done in all places where they occur, without perplexing the order of this treatise: Therefore I chose rather to sum them up here by way of appendix.

The causes of the following specialities of the female bones may be reduced to these three:

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The causes of the following specialities of the female bones may be reduced to these three:

three: 1. A weak lax constitution. 2. A sedentary unactive life, increasing that constitution. 3. A proper frame for being mothers.

The bones of women are smaller in proportion to their length than those of men; because the force of their muscles is not so great, nor is such strong external force applied to them to prevent their stretching out in length.

The depressions, ridges, scabrous surfaces and other inequalities made by the muscles, are not so conspicuous in them; because their muscles are neither so thick nor strong, nor so much employed, to make so strong prints on their bones.

Their *os frontis* is more frequently divided by a continuation of the *sagittal* suture, which depends on the first and second general cause assigned above, for the specialities in their bones; as will appear after reflecting on the account given formerly of the middle internal spine of this bone.

Their *clavicles* are less crooked; because their arms have been less forcibly pulled forwards, which in our *European* women, especially those of distinction, is more hindered by their garb.

Their *sternum* is more raised by long cartilages below, that the *thorax* might be thereby widened in some proportion to what it is shortened by the pressure upon the *diaphragm*, when they are with child.

The defect of bone, or the hole in the middle of the *sternum*, is oftenest found in them.

them, to allow the passage of the mammary vessels, say some; but, in my opinion, this is owing to a lax constitution, by which the ossification is not so soon completed as in men, where the action of the solids is vigorous, and the circulation of the fluids is brisk; for a much smaller hole might have served this purpose; and the branches of the internal mammary vessels which are sent to the external parts of the *thorax*, do not pass here, but between the cartilages of the ribs, before these are joined to the *sternum*.

The *cartilago xiphoides*, is oftener bifurcated in women than men, for the reason assigned in the preceeding paragraph, viz. a less forcible power of ossification.

The superior cartilages of the ribs sooner ossify, to support the weight of the *mamma*.

The middle cartilages are more flat and broad by the weight of the breasts.

The inferior cartilages are longer, for enlarging the chest.

Weak women who have born many children when young, often have the *vertebra* of their back bended forewards, and their *sternum* depressed, or become round-shouldered and flat breasted (a) by the pressure and weight of the impregnated *uterus*, and by the strong action of the abdominal muscles.

The *os sacrum* is broader and turned much more backwards, for enlarging the *pelvis*.

The *os coccygis* is more moveable, and much is bended forewards, to facilitate the birth.

The

(a) Cheselden, Anatomy, book 1. chap. 3.

The *ossa ilium* are more hollow, and more reflected outwards, and consequently further removed from each other, in order to widen the lower part of their *abdomen*; and for the better support of the impregnated *uterus*.

The ridge on the upper part of the *os pubis* is larger in such women as have born children being extended by the strong action of the *musculi recti abdominis*.

The cartilage between the two *ossa pubis* especially in women who have born children is thicker than in men, by which the *pelvis* is more capacious in females.

The conjoined surfaces of the *ossa pubis* and of the *ossa innominata* and *sacrum* are less the angle under the *symphysis* of the *ossa pubis* is much larger, and the arches formed below and behind by the *ossa ilium* and *ischium* are wider, which, with the freighter *os sacrum* and more distant *tubera ischii*, leave a large passage for the exclusion of the child at birth.

The great tuberosity of the *ossa ischium*, flatter in women than in men, because it is more pressed upon in the sedentary life which females enjoy.

In consequence of the *pelvis* of women being wider, the articulations of their thigh bones must be farther removed from each other, and therefore a larger space is left for procreation and birth of children (a); which distance of the thighs, may be one reason why women in running generally shuffle more from

(a) Albin. De ossib. § 339.

from one side to the other than men, to preserve the center of gravity of their bodies from falling too far to a side of the joint of the thigh that supports them when the other is raised, which would endanger their stumbling to the ground.

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THE  
ANATOMY  
OF THE  
HUMAN NERVES.

AND

A DESCRIPTION of the HUMAN  
LACTEAL SAC and DUCT.

THE EIGHTH EDITION.

By ALEXANDER MONRO *Senior*, M. D. and P. A.



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# P R E F A C E

To the Seventh Edition.

BEING informed that the following Essays have been useful to the students in anatomy, I have caused them to be reprinted with such amendments as I thought necessary.

That offence might not be given, I have treated all the opinions concerning the disputed physiology of the nerves with that deference which the uncertainty of the subject required; and have not only concealed the names of the writers whose sentiments were different from mine, but have shunned quotations from those whom I approve, lest the knowledge of the latter should be a key to discover the former by.

Descriptions of the very minute ramifications of the nerves are obscure to the young gentlemen for whose use I write; and therefore I have taken notice only of the larger branches in the description of the particular nerves.

The first occasion of my publishing my great Master Boerhaave's doctrine concerning the Systole and Diastole of the heart, was to prevent the imputation I might have lain under of assuming

ming it to myself, when my worthy Master and good friend Mr Cheselden inserted it into his anatomy, as communicated by me, without mentioning Boerhaave's name. Having now taken away all grounds of such imputation and the doctrine, though simple and beautiful, not appearing sufficient to account for the phænomena of the motions of the heart, I have omitted it in this edition.

The description of the receptaculum chyli and thoracic duct is more accurate, than in the common systems of anatomy; and on that account is here republished.

The corrections and additions made in this edition of the anatomy of the bones, and of these Essays, show, that I pretend not to Perfection; but I would however wish, that no more faults were imputed to me than what are really my own.

TH

T H E  
A N A T O M Y  
O F T H E  
H U M A N N E R V E S.

Of the N E R V E S in general.

1. **T**H E numerous turns which the *carotid* and *vertebral* arteries make before they pass through the *dura mater*, these arteries having neither swelling muscles nor pressure of the atmosphere to assist the course of the blood in them after they enter the skull, and their division into innumerable communicating branches in the *pia mater*, and its processes, shew, that the liquors must move more slowly and equally in them than in most other parts of the body.

2. By the assistance of injections and microscopes, the very minute branches of these vessels (§ 1.) are discovered to go from the *pia mater*, into the *cortex*, cineritious, or grey coloured part of the *cerebrum*, *cerebellum*,  
E c

*bellum*, and *spinal marrow*; whereas we can only see longitudinal vessels, without numerous ramifications or reticular plexuses, in the white medullary substance of these parts.

3. The continuity of the *cortex* with the *medulla* of the *encephalon* and *spinal marrow* is observable with the naked eye, and is more distinctly seen with the assistance of a microscope.

4. In dissecting the *brain* and *cerebellum*, we see the small beginnings of the *medulla* proceeding from the *cortex*, and can trace its gradual increase by the addition of more such white substance coming from the *cortex*.

5. Both these substances (§ 4.) are very succulent; for being exposed to the air to dry, they lose more of their weight than most of other parts of the body do.

6. In several places we can observe the *medulla* to be composed of fibres laid at each of others sides.

7. The medullary substance is employed in forming the white fibrous cords, which have now the name of *nerves* appropriate to them. Within the skull we see the nerve to be the medullary substance continued; and the *spinal marrow* is all employed in forming nerves.

8. The common opinion concerning the rise of the nerves, founded on a superficial inspection of those parts, is, that the nerves are propagated from that side of the *encephalon*, at which they go out of the skull. But having been remarked, after a more strict inquiry, and preparing the parts by maceration



in water, that the medullary fibres decussate or cross each other in some parts of the *medulla*; as for example, at the *corpus annulare*, and beginning of the *spinal marrow*: And practical observators having related several examples of people whose brain was hurt on one side, while the morbid symptom, palsy, appeared on the other side of the body, of which I have seen some instances; and experiments made on brutes having confirmed these observations, it has been thought, that the nerves had their rise from that side of the *encephalon*, which is opposite to their egress from the skull. It may however still be said, that this last opinion is not fully demonstrated, because a decussation in some parts is not a proof that it obtains universally; and if there are examples of palsy of the side opposite to where the lesion of the brain was, there are also others, where the injury done to the brain and the palsy were both on the same side.

9. The nerves are composed of a great many threads lying parallel to each other, or nearly so, at their exit from the *medulla*.

This fibrous texture is evident at the origin of most of the nerves within the skull; and in the *cauda equina* of the *spinal marrow*, we can divide them into such small threads, that a very good eye can scarce perceive them; but these threads, when looked at with a microscope, appear each to be composed of a great number of smaller threads.

10. How small one of these fibrils of the nerves is, we know not; but when we consi-

der that every, even the most minute part of the body is sensible, and that this must depend on the nerves (which all conjoined, would not make a cord of an inch diameter) being divided into branches or filaments to be dispersed through all these minute parts, we must be convinced that the nervous fibrils are very small. From the examination of the *minimum visibile*, it is demonstrated, that each fibre of the *retina* of the eye or expanded optic nerve cannot exceed the size of the 32,400 part of a hair.

11. the medullary substance, of which the nervous fibrils are composed, is very tender and would not be able to resist such forces; the nerves are exposed to within the bone, nor even the common force of the circulating fluids, were not the *pia mater* and *tunica arachnoidea* continued upon them; the former giving them firmness and strength, and the latter furnishing a cellular coat to connect the threads of the nerves, to let them lie soft and moist, and to support the vessels which go with them.

It is this cellular substance that is distended when air is forced through a blow pipe thrust into a nerve, and that makes a nerve appear all spongy, after being distended with air till it dries; the proper nervous fibrils shrivelling so in drying, that they scarce can be observed.

13. These coats (§ 11.) would not make nerves strong enough to bear the stretch and pressure they are exposed to in their course to the different parts of the body; and the

fore, where the nerves go out at the holes in the *cranium* and *spine*, the *dura mater* is generally wrapt closely round them, to collect their disgregated fibres into tight firm cords; and that the tension which they may happen to be exposed to, may not injure them before they have got this additional coat, it is firmly fixed to the sides of the holes in the bones through which they pass.

13. The nervous cords thus composed of nervous fibrils, cellular coat, *pia* and *dura mater*, have such numerous blood vessels, that after their arteries only are injected, the whole cord is tinged of the colour of the injected liquor; and if the injection is pushed violently, the cellular substance of the nerves is at last distended with it.

14. A nervous cord, such as has been just now described, (§ 13), has very little elasticity, compared with several other parts of the body. When cut out of the body, it does not become observably shorter, while the blood vessels contract three eighths of their length.

15. Nerves are generally lodged in a cellular or fatty substance, and have their course in the interstices of muscles, and other active organs, where they are guarded from pressure; but in several parts they are so placed, as if it was intended that they should there suffer the operating force of arteries, or the pressure of the contracting fibres of muscles.

16. The larger cords of the nerves divide into branches as they go off to the different parts; the branches being smaller than the

trunk from which they come, and making generally an acute angle where they separate.

17. In several places, different nerves unite into one cord, which is commonly larger than any of the nerves which form it.

18. Several nerves, particularly those which are distributed to the bowels, after such union (§ 17.), suddenly form a hard knot considerably larger than all the nerves of which it is made. These knots were called *corpora olivaria*, and are now generally named *ganglions*.

19. The *ganglions* have thicker coats, more numerous and larger blood-vessels than the nerves; so that they appear more red and muscular. On dissecting the *ganglions*, fibres are seen running longitudinally in their axes, and other fibres are derived from their sides in an oblique direction to the longitudinal ones.

20. Commonly numerous small nerves, which conjunctly are not equal to the size of the *ganglion*, are sent out from it, but with a structure no way different from that of other nerves.

21. The nerves sent to the organs of the senses, lose there their firm coats, and terminate in a pulpy substance. The *optic nerves* are expanded into the soft tender webs, the *retinae*. The *auditory nerve* has scarce the consistency of *mucus* in the *vestibulum*, *cochlea*, and several *circular canals* of each ear. The *papillae* of the nose, tongue and skin, are very soft.

22. The nerves of muscles can likewise be traced till they seem to lose their coats by becoming very soft; from which, and what we observed of the sensory nerves (§ 21.); there

real



reason to conclude, that the muscular nerves are also pulpy at their terminations, which we cannot indeed prosecute by dissection.

23. It would seem necessary that the extremities of the nerves should continue in this soft flexible state, (§ 21. 22.), in order to perform their functions right: For, in proportion as parts become rigid and firm by age, or any other cause, they lose of their sensibility, and the motions are more difficultly performed.

24. Though the fibres in a nervous cord are firmly connected, and frequently different nerves join into one trunk, or into the same ganglion; yet the sensation of each part of the body is so very distinct, and we have so much the power of moving the muscles separately, that, if the nerves are principal agents in these two functions, which I shall endeavour to prove they are, we have reason to believe that there is no union, confusion, or immediate communication of the proper nervous fibrils, but that each fibre remains distinct from its origin to its termination.

25. Changes produced any way upon the coats of the nerves, cannot however miss to affect the nervous fibrils. The cellular substance may be too full of liquor, or may not supply enough; the liquor may not be of a due consistence, or it may be preternaturally obstructed and collected. The *pia* or *dura mater* may be too tense, or too lax; their vessels may be obstructed; their proper nerves may be violently irritated, or lose their power of acting; and a great many other such changes may happen, which will not only occasion disorders



orders in particular nerves, but may be a cause of the *sympathy* so frequently observed among the nerves; which is so necessary to be attentively regarded in a great many diseases, in order to discover their true state and nature that, without this knowledge, very dangerous mistakes in the practice of physic and surgery may be committed.

26. Many experiments and observation concur in proving, that when nerves are compressed, cut, or any other way destroyed, the parts served by such nerves, farther from the head or spine than where the injuring cause has been applied, have their sensations, motions, and nourishment weakened or lost while no such effects are seen in the parts nearer to the origin of those nerves; and in such experiments where the cause impeding the nerves to exert themselves could be removed, and the structure of the nerves not injured; as for example, when a ligature made upon a nerve and stopping its influence has been taken away, the motion and sensation of the parts soon were restored. From which would appear, that the nerves are principal instruments in our sensations, motions, and nourishment; and that this influence of the nerves is not inherent in them, without the communication between these cords and the origin is preserved.

This conclusion is just, notwithstanding that sometimes, upon cutting a nerve, the effects above mentioned have been felt for a short time; but afterwards the person was sensible

of no numbness or immobility; for where-ever this is said to have happened, the cut nerve was only one of several which were sent to the member; the want of whose influence was felt no longer, than till the habit was acquired of performing the functions easily by the other nerves.

Nor is it of greater weight as an objection, that sometimes when a ligature is drawn very hard upon a nerve, and then is taken away, the nerve never again recovers its influence upon the parts it is distributed to beyond the ligature, but is of as little effect as if it had been cut through; which is to say, that its texture has been altered beyond recovery. The same thing is to be seen by tying a thread tight round a tender twig of any vegetable; it decays.

27. Experiments and observations shew too, that when parts of the *encephalon* or *spinal marrow* have been irritated, compressed, or destroyed, the parts of the body, whose nerves had their origin from such affected parts of the *encephalon* or *spinal marrow*, became convulsed, paralytic, insensible, or wasted; and in such cases where the injuring cause could be removed from the origin of the nerves, the morbid symptoms observed in the parts to which these nerves were distributed, went off upon the removal of that cause. From which it is thought reasonable to conclude, that the nerves must not only have a communication with their origin, but that the influence they have upon the parts they are distributed to depends

pend on the influence which they derive from the *medulla encephali* and *spinalis*.

28. Though the *spinal marrow* has its own vessels and ciceritious substance which assists to form its *medulla*; yet a very large share of the medullary substance within the spine is derived from the *encephalon*, whose *medulla oblongata* descends from the head, and the influence of the *spinal marrow* on its nerves depends in great measure on this *medulla oblongata* of the head. Hence an injury done to any part of the *spinal marrow*, immediately affects all the parts whose nerves have their origin below where the injuring cause is applied. A luxation of a *vertebra* in the loins makes the lower extremities soon paralytic; a transverse section of the *medulla* at the first *vertebra* of the neck, soon puts an end to life.

29. If such causes produce constantly such effects (§ 26. 27. 28.) in us and other creatures living in nearly the same circumstances as we do, the conclusions already made must be good, notwithstanding examples of children and other creatures being born without brain or *spinal marrow*; or notwithstanding that the brains of adult creatures can be much changed in their texture by diseases; and that *taoises*, and some other animals, continue to move a considerable time after their heads are cut off. We may be ignorant of the particular circumstances requisite or necessary to the being or well-being of this or that particular creature, and we may be unable to account for a great many *phenomena*; but we must believe our eyes in the examination

facts

facts; and if we see constantly such consequences from such actions, we cannot but conclude the one to be the cause and the other the effect. It would be as unjust to deny the conclusions made in the three preceding articles, because of the seemingly preternatural phenomena mentioned at the beginning of this, as it would be to deny the necessity of the circulation of the blood in us and most quadrupeds, because a frog can jump about, or a tortoise can walk long after all the bowels of its thorax and abdomen are taken out, or because the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almost universally allowed that the nerves are the principal instruments in our sensations, motion, and nourishment; and that the influence which they have is communicated from their origin, the *encephalon* and *medulla spinalis*. But authors are far from agreeing about the manner in which this influence is communicated, or in what way nerves act to produce these effects.

30. Some alledge, that *the nervous fibres are solid cords acting by elasticity or vibration*; others maintain, that *those fibres are small pipes conveying liquors, by means of which their effects are produced*.

31. The gentlemen, who think the nervous fibres solid, raise several objections to the other doctrine; which I shall consider afterwards; and endeavour to shew the fitness of their own doctrine to account for the effects commonly observed to be produced by the nerves.

The



The objects of the senses plainly (say they) make impulses on the nerves of the proper organs, which must shake the nervous fibrils, and this vibration must be propagated along the whole cord to its other extremity or origin, as happens in other tense strings; and these vibrations being differently modified, according to the difference of the object, and its different application, produce the different ideas we have of objects.

32. To this account of sensation, it is objected, *first*, That nerves are unfit for vibrations, because their extremities, where objects are applied to them, are quite soft and papery (§ 21.), and therefore not susceptible of the vibrations supposed; and if there could be any little tremor made here by the impulse of objects, it could not be continued along the nervous cord, because the cellular substance by which each particular fibre is connected to the neighbouring ones (§ 11.), and the fatty substance which the nervous cord is immersed in (§ 12.) would soon stifle any such vibratory motion.

A *second* objection to this doctrine is, That supposing the nerves capable of vibrations by impressions of objects, these vibrations would not answer the design. For if what we know of other vibrating strings, to wit, that the tone remains the same, unless their texture, length, or tension is altered, and that different substances striking them do no more than make the sound higher or lower; if these properties are to be applied to nerves, then it will follow, that the same nerve would constantly convey the same idea, with no other variation



than of its being weaker and stronger, whatever different objects were applied to it; unless we supposed the nerve changed in its texture, length, or tension, each time a different object is applied; which, it is presumed, no body will undertake to prove does happen.

Nay, 3<sup>d</sup>y, If ever such a variety of vibrations could be made, our sensations would notwithstanding be confused and indistinct, because the tremulous nervous fibre being firmly connected and contiguous to several other fibres of the same cord, would necessarily shake them too, by which we should have the notion of the object as applied at all the different parts where the extremities of these fibres terminate.

33. In whatever way the favourers of the doctrine of solid nerves please to apply the elasticity of nerves to the contraction of muscles, their adversaries insist that nerves are too weak to resist such weights as the muscles sustain; they would surely break, especially as they are in a great measure, if not wholly, deprived of their strong coats before they come to the part of the muscle they are immediately to act upon (§ 22.)—The nerves being found to have little or no elasticity to shorten themselves (§ 14.), shews them altogether unfit for such an office as this of contracting muscles in the way proposed of their acting by elasticity; and when a nerve is viewed with a microscope while the muscles it serves are in action, no contraction or motion is observed in it.——  
 Nay, if they were elastic, they would equally exert their power of contracting muscles near to their origin as well as farther from it,

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when they were put into contraction or vibration, by irritation of any part of them. The former however does not happen

34. As a further objection against either motion or sensation being owing to the elasticity of the nerves, it is said, that if this doctrine was true, the sensations would be more acute and the contractions of muscles would be greater and stronger, when the parts become firmer and more rigid by age; for then their elasticity is increased: Whereas, on the contrary, it appears (§ 23.) that then the sensations are blunted, and muscular contraction becomes less and weaker.

35. If the nerves were granted to be elastic and to communicate a springy force to all the parts they are distributed to, they might appear necessary in this view to assist the application of the nutritious particles of the fluids to the sides of the vessels which these particles were to repair; and so far might well enough account for the share which nerves are thought to have in nutrition: But if we cannot make use of elasticity in the other two functions of sensation and motion, we must also endeavour to find out some other way for the nerves to act in nutrition; which will be done afterwards.

36. Having thus stated the reasons for an objection against the nerves acting as solid strings, let us likewise relate the arguments for nerves being pipes, and the objections to this doctrine.

A great argument of those who think the nerves to be tubes conveying liquors, is that

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strong analogy of the brain and nerves to other glands of the body and their excretories, where a manifest secretion of liquor is made in the glands, to be conveyed by the excretories to the proper places in which it ought to be deposited: They think that the vascular texture of the *cortex* of the *encephalon* and *spinal marrow* (§ 2.), the continuation of the *cortex* in forming the medullary substance (§ 3. 4.), the fibrous texture (§ 6.), and succulent state of this *medulla* (§ 5), and its being wholly employed to form the nerves (§ 7.), where the fibrous texture is evident (§ 9.); all these things, say they, conspire to shew such a strong analogy between these parts and the other glands of the body, as carries a conviction that there is a liquor secreted in the *encephalon* and *spinal marrow*, to be sent out by the nerves to the different parts of the body.

37. The following objections are raised to this argument in favour of liquor conveyed in the nerves from the analogy of the glands. 1<sup>st</sup>, Other glands, it is said, have their excretories collected into a few large pipes, and not continued in such a great number of separate pipes, as far as the places where the liquors are deposited; which last must be the case, if the nerves are the excretories of the glandular brain. 2<sup>dly</sup>, We see the cavities, and can examine the liquors in the excretories of other glands much smaller than the brain; which cannot be done in the nerves. 3<sup>dly</sup>, If the nerves were pipes, they would be so small, that the attraction of the liquors to their sides, would prevent that celerity in the mo-



tion of the liquors, which is requisite to sensations and motions. 4thly, If the nerves were pipes, they would be cylindrical ones, and consequently not subject to diseases; or at least we could have no comprehension of the diseases in them.

38. The answer to the 1st of these objections is, That there are other glands where there is a manifest secretion, and in which the disposition of the excretories is in much the same way as in the *encephalon*: The kidneys for example, have a reticulated *cortex* of vessels, from which the *Eustachian* or *Bellinian medulla*, consisting of longitudinal fibres and a few blood vessels in the same direction, proceeds, and this *medulla* is collected into ten, twelve, or more *papillæ*, each of which is formed of numerous small separate pipes, which singly discharge the urine into the large membranous tubes; and these united form the *pelvis*. Upon comparing this texture of the kidneys with that of the *encephalon* (§ 2. 3. 4. 5. 6. 7. 9.) the analogy will be found very strong.

39. In answer to the 2d objection, in § 3 it is granted, that microscopes, injections, and all the other arts hitherto employed, have not shewn the cavities of the nervous fibrils, or the liquors contained in them; and from what was said (§ 10.) of the smallness of the nervous fibrils, it is not to be expected that even they should be seen. But so long as such a number of little animals can every hour be brought to the objectors, in which they can little demonstrate the vessels or contain fluids, it will not be allowed to be conclusive reasoning

reasoning, that because ocular demonstration cannot be given of either the tubes or their contents, therefore they do not exist. For if we have any notion of an animal, it is its being an hydraulic machine, which has liquors moving in it as long as it has life; if therefore such little animals have vessels and liquors which we cannot see, why may not some of the vessels and liquors of the human body be also invisible to us?

To avoid this answer to the objection, it is further urged; That though we might not see the nervous tubes or the liquors they contain, as they naturally flow; yet if such liquors really exist, they ought to discover themselves, either by a nerve's swelling when it is firmly tied; or that, however subtle their fluids are, they might be collected in some drops, at least, when the cut end of a nerve of a living animal is kept some time in the exhausted receiver of an air-pump. It is affirmed, that neither did the tied nerve swell between the brain and ligature, nor was there any liquor collected in the receiver of the [air-pump; from which it is concluded, that there is no liquor in the nerves.

Some, who say they have tried these experiments, affirm, that in young animals the nerve does swell above the ligature, and that liquor does drill out upon cutting a nerve.

— Whether swelling or liquor is seen or is not seen in these experiments, no conclusion for or against a nervous fluid can be made from them; for the swelling of the

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nerve after it is tied, or the efflux of liquor from its extremity, will never prove either to be the effect of the fluid in the proper nervous fibrils, so long as they might be occasioned by the liquors in the larger vessels of the cellular substance of the nerves; and if the same vessels of the coats of the nerves do not discover their liquors by these experiments, it is far less to be expected, that the much more subtile nerves will discover theirs.

40. The 3<sup>d</sup> Objection to the doctrine of the brain being a gland, and the nerves its excretories, supposes a more rapid motion necessary in the fluid of the nerves, than what most of the defenders of the nervous fluid will not allow; and is afterwards to be considered particularly in a more proper place.

41. The 4<sup>th</sup> Objection being, That if nerves are excretories of a gland, they must be cylindrical pipes, in which no obstructions or diseases would happen; but since we do see diseases in the nerves, they must therefore not be such excretories. The answer is, That diseases happen often in the excretories of other glands, as of the liver, kidneys, &c. notwithstanding their cylindrical form, and their much shorter and less exposed course. When we consider the very tenuous substance of the brain, the vast complication of vessels there, the prodigious smallness of the pipes going out from it, the many moving powers which the nerves are to undergo the shock of, and the many chances which the vessels, membranes, and cellular substance accompanying the nerves have of being

ordered

ordered, and then affecting the nervous fibrils, we have very great reason to be surprised, that these cylindrical pipes are not much more frequently put out of order, by too great or too small a quantity of liquors; by too viscid or too thin fluids; by liquors consisting of too mild and sluggish particles, or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the pipes being too much straitened, or too much enlarged; and by a great many other varieties of circumstances which might be thought capable of disturbing the functions of the nerves, supposing them to be cylindrical excretories of the gland, the brain.

42. The numerous vessels of the *encephalon* have brought some of the gentlemen who assert the nerves to be solid, to acknowledge, that there is a liquor secreted in the brain: But then they will not allow that this liquor is sent out by the proper nervous fibrils; but that it is poured into the cellular substance in which the nerves lie, to keep them moist and supple, and therefore fit for exerting their elasticity, vibration, &c. by which, in their opinion, the effects commonly ascribed to nerves are produced.

43. Besides the objections already mentioned (§ 32. 33.) against the nerves acting as elastic strings, this opinion has some other difficulties which may be objected to it: For instance, there is not one analogous example in the whole body of liquors secreted in a large gland,



gland, to be poured into a cellular substance as is here supposed; the liquors in the cells of the *tela cellularis* of other parts are separated from the little arteries which are distributed to these cells.

Further, it cannot be imagined, how a liquor secreted in the *cortex* of the brain should make its way through the *medulla*, to come out into the cellular membranes on the surface of that *medulla*.

*Lastly*, A very simple experiment, of injecting water by the artery of any member and thereby filling the cellular substance of the nerves of that member, shews evidently, that the liquor of the *cellular* substance of the nerves has the same fountain as the liquor has in the *tela cellularis* any where else, that is from the little arteries dispersed upon it.

44. The doctrine of a fluid in the nerves is not only thus supported by the analogy of the brain and nerves to the other glands and their excretories, but those who maintain this doctrine mention an experiment which they think directly proves a fluid in the nerves. It is this: After opening the thorax of a living dog, catch hold of and press one or both the *phrenic* nerves with the fingers, the *diaphragm* immediately ceases to contract; cease to compress the nerves, and the muscle acts again. A second time, lay hold of the nerve of nerves some way above the *diaphragm*, its motion stops. Keep firm the hold of the nerve, and, with the fingers of the other



hand strip it down from the fingers which make the compression towards the *diaphragm*; and it again contracts: A repetition of this part of the experiment three or four times, is always attended with the same effects; but it then contracts no more, strip as you will, unless you remove the pressure, to take hold of the nerves above the place first pinched; when the muscle may again be made to contract, by stripping the nerve down towards it. This experiment I have done with the success here mentioned. Let any one try if he can imagine any other reasonable account of these appearances, than that the pressure by the fingers stopped the course of a fluid in the nerve; that so much of this fluid as remained in the nerve, betwixt the fingers and *diaphragm* was forced into that muscle by stripping, and when it was all pressed away, the fingers above preventing a supply, the muscle contracted no more till the fingers were removed, and a fresh flow by that means was received from the spinal marrow, or from that part of the nerve which had yet not been stripped.

It has been objected to the conclusions from this experiment, 1. That the *diaphragm* is set in motion by stripping the nerve from, as well as towards, this muscle; and this may be well expected; for a liquor in such small pipes is ordered to flow backwards by ligature, pinching fingers, or even the flow of their liquors from the fountain, will regurgitate forewards with velocity, when pressed backwards. We see

see it happen in the stalks of tender succulent plants.

2. It is said, that muscles cease to act when their veins are tied, as well as when their arteries or nerves are tied or cut, but that muscles continue to act when their veins are cut by which it would appear, that the overloading of the vessels is an impediment to the action of muscles, and therefore the ceasing of the action when their arteries or nerves are tied or cut, may also be owing to the liquor in the branches of these pipes of muscles stagnating when it is not propelled by the flow of more liquor from their trunks, and not to any interfluence or moving power, which now ceases to be conveyed to them.

It is to be observed in making the experiments just now mentioned, that the contraction of the muscles ceases soonest when the nerves are tied, and latest when the veins are tied.—That when veins are tied, not only are the vessels overloaded, but all the cellular substance of the muscles is filled with coagulated blood, whereas when the arteries and nerves are tied the reverse is seen, the muscles are lax and less bulk. So that in these cases the ceasing of the contraction of the muscles seems to depend on very different causes, to wit, a deprivation of necessary liquors in the one, and redundancy of superfluous blood in the other. An elastic stick may be deprived of its elasticity by being made either too dry or too wet.

45. Some gentlemen, convinced of the reasonableness of the secretion of a liquor from the brain to be sent out by the nerves, but not comprehending

comprehending how a fluid could have such a rapid retrograde motion as they imagined was necessary for conveying the impressions of objects made on the extremities of nerves to the *sensorium*, supposed two sorts of nerves; one that conveyed a liquor for muscular motion and nutrition; the other composed of solid nerves, that were to serve for organs of the senses, to convey the vibrations communicated from objects to the *sensorium*.

46. To this opinion (§ 45.) the objections against the sensory nerves acting by vibration (§ 32.) may be made; and there is so little reason to suspect any difference in the texture of the different parts of the brain or nerves, that, on the contrary, the structure is every where similar, and branches of the same nerve often serve both for sensation and motion.

How little necessity there is for supposing extremely rapid motions of the nervous fluid, is to be examined soon.

47. The hypothesis of great celerity in the motion of the fluid of the nerves being necessary, gave also rise to another division of the nerves, into *arterious* or *effluent*, and *venous* or *refluent*. It was said, that muscular motion and nutrition depended on the arterious nerves; and that the sensations depended on an accelerated motion of the nervous fluid towards the brain, by the impressions which the objects of the senses make upon the venous nerves. By this supposition the absurdity of rapid fluxes and refluxes in the same canal

was prevented, and an advantage was thought to be gained by it, of saving too great a waste of the fluid of the nerves, which otherwise the *encephalon* and *spinal marrow* could not supply in sufficient quantity to answer all the exigencies of life.

48. To this opinion (§ 47.) it has been objected, 1<sup>st</sup>, That there is no example in the body of a secreted liquor being returned immediately and unmixed to the gland by which it was originally separated from the mass of blood; which would be the case were the venous nerves. 2<sup>dly</sup>, There is no occasion for saving the fluid of the nerves in the way proposed; the organs for secreting that fluid being large enough to supply all that is necessary of it in the common functions of life. 3<sup>dly</sup>, If the fluid of the nerves was to be thus kept in a perpetual circulation, it would soon become too acid for continuing with safety in such sensible tender vessels as the brain and nerves are composed of. 4<sup>th</sup>, This hypothesis will not answer the design for which it was proposed: For though the momentary application of an object might cause an acceleration in the fluid of venous nerves, yet if the object was kept applied to the nerves, it would stop their fluid, so that it could not go forward to the brain; and therefore, according to this doctrine, we should be sensible of no objects except those whose application to the organs of the senses was momentary.

49. Let us now suppose it probable, that the *encephalon* and *spinal marrow* secrete a liquor



from the blood which is sent into all the nerves, and that by the means of this liquor, the nerves perform the offices commonly assigned to them; it is next necessary to inquire what kind of liquor this is, and how it moves, in order to determine how well its nature and motion are fitted for performing what is expected from it.

50. The liquor of the nerves has been fancied by some to be of a very strong acid or alkaline nature: But since none of our juices appear to be of this sort, and since such liquors irritate and destroy the parts of the body which they are applied to, we cannot conceive how the brain can separate, or the nerves could bear any thing of such an acrid nature. This tenderness and sensibility of these organs must hinder us absolutely from supposing that the liquor of the nerves can be acrid or pungent, or of the nature of spirit of wine, hartshorn, &c.

51. Some have imagined the liquor of the nerves to be capable of vast explosion like gun-powder, or of violent sudden rarefaction like air, or of strong ebullition like boiling water, or the mixture of acids with alkaline liquors. But as the mass of blood from which this fluid is derived, is not possessed of any such properties, we cannot suppose the blood to furnish what it has not in itself. Besides, all these operations are too violent for the brain or nerves to bear; and when once they are begun, they are not so quickly controlled or restrained, as experience teaches us the nerves can be made to cease from acting.

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52. We are not sufficiently acquainted with the properties of an *ether* or *electrical effluvia* pervading every thing; to apply them justly in the animal œconomy; and it is as difficult to conceive how they should be retained or conducted in a long nervous cord. These are difficulties not to be surmounted.

53. The surest way of judging what kind of liquor this of the nerves must be, is to examine the liquors of similar parts of the body. All the glands separate liquors from the blood much thinner than the compound mass itself; such is the liquor poured into the cavity of the *abdomen*, *thorax*, *ventricle of the brain*, the *saliva*, *pancreatic juice*, *lymph*, &c. Where ever there is occasion for secreted liquors being thick and viscid, in order to answer better the uses they are intended for, nature has provided reservoirs for them to stagnate in, where their thinner parts may be carried off by the numerous absorbent veins dispersed on the sides of the cavities; or they may exhale where they are exposed to the open air. The *mucus* of the *nose* becomes viscid by stagnation; for, when it is immediately secreted, it is thin and watery, as appears from the application of sternutories, &c. The *cerumen* of the ears is of a watery consistence, when just squeezing out. The *mucus* of the alimentary canal grows thick in the *lacunæ*. The *bile* in the hepatic duct has little more consistence than lymph; that in the gall-bladder is viscid and strong. The *urine* is much more watery as it flows from the kidneys, than when it is condensed.

erected from the bladder. The *seed* is thin as it comes from the testicles, and is concocted in the *vesicula seminales*, &c.

54. Hence (§ 53.) we may safely conclude, that a thin liquor is secreted in the *cortex encephali* and *spinal marrow*; and seeing the thinness of secreted liquors is generally, as the divisions of the vessels, into small subtile branches, and that the ramifications within the skull are almost infinitely subtile, the liquor secreted in the *encephalon* may be determined to be among the finest or thinnest fluids.

55. Seeing also that we can observe no large reservoir, where the liquor secreted in the *cortical substance* is deposited, to have its finer parts taken off, we have reason to think, that it goes forward into the nerves in the same condition in which it is secreted.

56. By fine or subtile animal liquors, is meant no more than those which are very fluid, and which seem to consist of a large proportion of watery particles, and a lesser one of the oily, saline, and terrestrious particles. Some of the liquors which we can have in sufficient quantity to make experiments with, are so fluid, and have so little viscosity or cohesion of parts, that when laid upon a piece of clean mirror, they evaporate without leaving a stain; such is the liquor ousing out from the surface of the *pleura*, the lymph, and several others.

If then, these liquors, which are subject to our examination, the secreting vessels of which are so large that we can see them, have such a small cohesion of parts, it might not

be unreasonable to say, that the liquor of the nerves is as much more fine and fluid than lymph as the vessels separating it are smaller; and therefore that the fluid of the nerve is a defecated water, with a very small proportion of the other principles extremely subtilized.

57. Two experiments are said to contradict this opinion of the liquor of the nerve being so fluid and subtile. One is, that upon cutting the *cauda equina* of a living animal, a liquor as viscid as the white of an egg drops out: The other is, that a wounded nerve yields a *glairy sanies*. But these do not appear to be the proper fluid of the nerves since it is evident, that what is discharged in both these cases, comes out of the cellular substance involving the nervous fibrils.

58. Considering how many experiments make it evident, that there is a constant uninterrupted stream of liquors flowing through all the canals of animals, which convey liquors composed of particles smaller than the diameter of their canal, which is always the case of the nerves in a natural state; it is surprizing how it ever could be thought that the liquid of the nerves should be obliged to flow from the brain to each muscle the moment we will; or that this liquor should flow back with the like swiftnefs from the extremity of each nerve, to which an object of sensation is applied. The nerves, as well as other excretories of the glands, always full of liquor; the degree of distension of the canals not being at all times alike even in

found state. But this happens without inconvenience, as the sides of the canals have a power to accommodate themselves to the present quantity, unless it is very much above or below the natural standard; in both which cases diseases ensue.

59. The motion of the fluid in the nerves is therefore not only constant, but it is also equal, or nearly so: For, though the blood in the larger arteries is moved unequally by the unequal forces, the contraction of the ventricle of the heart, and the weaker power, the *force* of the arteries; yet the difference between these two moving powers comes to be less and less perceptible, as the arteries divide into smaller branches; because of the numerous resistances which the liquors meet with, and because the canals they move in become larger, till in the very small arterious branches, there is no sensible difference in the velocity of the liquors from the effect of the heart or arteries. The motion of the fluids must still be more equal in the excretories of glands, and particularly in those where the vessels have divided into very minute branches, and the liquors have no other propelling force but the heart and arteries, (see § 1.); therefore the nervous fluid moves constantly, equally, and slowly, unless when its course is altered by the influence of the mind, or by the pressure of some neighbouring active organ.

60. As there is neither proof nor probability of the *valves* supposed by some in nerves, we are not to assume them in accounting for a-  
*phenomena*.



61. We have not, and perhaps cannot have any idea of the manner in which mind and body act upon each other; but if we allow that the one is affected by the other, which none deny, and that the fluid of the nerves (whatever name people please to give it) is a principal instrument which the mind makes use of to influence the actions of the body, or to inform itself of the impressions made on the body, we must allow that the mind can direct this instrument differently, particularly as to quantity and celerity, though we must remain ignorant of the manner how many *phenomena* depending on this connection of mind and body are produced. Thus we would in vain attempt to account for animals continuing, after their heads were struck off or their hearts were cut out to perform actions begun before they suffered any injury.

62. Let us now suppose the nervous fluid such as has been argued for, to wit, a very fluid saponaceous water, moving in a constant, equal, slow stream; from the *encephalon* and *spinal marrow*, in each of the proper nervous fibres, except when the motion is changed by some accessory cause, such as the mind, pressure of other parts, &c.; and let us examine how well such a supposition will agree with the *phenomena* of the three great functions, nutrition, sensation, and muscular motion, which the nerves are principal instruments of.

63. In general, we may say, that nerves can carry fluids to the most minute part of the body, to supply what is wasted in any of the solids; that the impression made by the ob-

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jects of the senses on the very soft pulpy extremities of the nerves of the organs of the senses, must make such a stop in the equal-flowing nervous fluid, as must instantaneously be perceptible at the fountain-head from which the pipes affected arise; that the constant flow of the liquor of the nerves into the cavities of the *muscular fibrillæ*, occasions the natural contraction of the muscles, by the as constant *nifus* it makes to increase the transverse and to shorten the longitudinal diameter of each fibre; and that it is only to allow the mind a power of determining a greater quantity of this same fluid with a greater velocity into what muscular fibres it pleases, to account for the voluntary strong action of the muscles.

64. But since such a superficial account would not be satisfactory, it will be expected, that the principal *phenomena* of these three functions should be explained by the means of such a fluid as has been supposed; and that the several objections against this doctrine should be answered: Let us attempt this; and where we cannot extricate ourselves from difficulties which may be thrown in, let us honestly acknowledge ignorance.

65. α. If water, with a very small proportion of oils and salts from the earth, proves a fit nourishment for vegetables, such a liquor as the fluid of the nerves has been described (§ 56.) may not be unfit for repairing the waste in animals.

β. The flow continual motion of this nervous fluid (§ 58. 59.) to the most minute parts of the body (§ 10.), is well enough calculated to supply

supply the particles that are constantly worn off from the solids by the circulation of the liquors and necessary actions of life.

7. The greater proportional size of the *encephalon* in young creatures than in adults, seems calculated for their greater proportional growth: For the younger the animal is, the larger *encephalon* and speedier growth it has.

8. A palsy and atrophy of the members generally accompanying each other, shew, that nourishment, sensation, and motion, depend on the same cause.

9. It was said (§ 26.), that the nerves were principal instruments in nutrition: It was not affirmed, that they were the sole instruments, and therefore an *atrophy* may proceed from the compression or other lesion of an artery without being an objection to the doctrine here laid down.

66. a. All objects of sense, when applied to their proper organs, act by impulse; and this action is capable of being increased by increasing the impelling force. In tangible objects, that is clearly evident; the closer they are pressed to a certain degree, the more distinct perception ensues. Odorous particles need the assistance of air moved rapidly, to affect our nose: Sapid substances, that are scarce sufficient to give us an idea of their taste by their own weight, are assisted by the pressure of the tongue upon the palate: The rays of light collected drive light bodies before them: Sound communicates a vibration to bodies in harmonic proportion with it.

The impulses made thus by any of these objects on the soft pulpy nerves (§ 21.), which are full of liquor, presses their sides or extremities, and their liquor is hindered to flow so freely as it did. The canals being all full (§ 58.) this resistance must instantaneously affect the whole column of fluids in the canals that are pressed, and their origins, and have the same effect as if the impulse had been made upon the origin itself. To illustrate this by a gross comparison: Let any one push water out of a syringe, through a long flexible pipe fixed to the syringe, and he is sensible of resistance or a push backwards, the moment any one stops the orifice of the pipe, or closes the sides of it with his fingers. This impulse made on the nerves, and thus communicated to their origin, varies according to the strength or weakness, the quickness or slowness, the continuance or speedy removal, the uniformity or irregularity, the constancy or alternation, &c. with which objects are applied to the nerves.

b. Whenever any object is regularly applied with due force to a nerve, rightly disposed to be impressed by it, and is communicated, as just now explained, to the *sensorium*, it gives a true and just idea of the object to the mind.

c. The various kinds of impulses which the different classes of objects make, occasion in animals, which ought to have accurate perceptions of each object, a necessity of having the different organs of the senses variously modified, so that the several impulses may be regularly

larly applied to the nerves in each organ; or, in other words, we must have different organs of the senses fitted to the different classes of objects.

d. As the objects have one common property of impulse, so all the organs have most of the properties of the organ of touching in common with the *papillae* of the skin. In the nose and tongue, this is evident: In some operations of the eyes we can also perceive this, as we may likewise do in some cases where matter is collected in the internal ear.

e. These properties common to the different objects and organs occasion frequently uncommon effects in the application of an object to an organ proper to another object of sensation; for sometimes we have the same idea as if the object had been applied to its own proper organ: At other times the object is as it were changed, and we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye to give us any idea of colours; yet when all light is excluded from the eyes, an idea of light and colours may be excited in us by coughing, sneezing, rubbing, or striking the eye-ball. ----- A cane vibrating, so as not to excite sound perceptible to the ear, applied to the teeth, raises a strong idea of sound; as a little insect creeping in the *meatus auditorius* also does. --- The fingers applied to two rough surfaces, rubbing on each other, are sensible of the sound they make; surgeons of any practice



in the cure of fractured bones can bear witness to the truth of this.-----The fingers dipped in acid and several other acrid liquors, have a sensation very like to tasting.-----

Smelling and tasting every body knows are subservient and assisting to each other. From such examples we have further proof of one general cause of our sensations, to wit, impulse from the objects; and of such a similarity and relation in the organs, as might give reason for imagining that any one of them would be capable of producing the effect of another, if the impulses of the different objects could be regularly applied to each.-----Hence light and sound may affect insects and other animals that have not eyes or ears.

f. If the impulse of an object is applied with due force, but irregularly, a confused idea of the object is raised. Distant objects are confused to *myopes*, as very near ones are to *presbytes*.

g. If the application of the impulse is regular, but the force with which it is applied is too weak, our perception of the object is too faint. One may whisper so low as not to be heard.

h. If the application of objects is too violent, and there is any danger of the tender organs of our senses being hurt or destroyed, an uneasy sensation we call *pain* is raised, whatever the organ thus injured is. The object of feeling affects every organ: Thus pressure, stretching, cutting, pricking, acrid salts, pungent oils, great heat, violent cold, &c. occasion pain, where ever they are applied.

Besides



Besides, every particular organ can be affected with pain by the too violent application of its own proper object. Too much light pains the eyes; very loud sound stuns the ears; very odorous bodies and too sapid objects hurt the nose and tongue. A pretty sure proof this, that the objects of our sense all act, and that the organs are all impressed in nearly the same way.

i. Since a middle impulse, neither too small nor too great, is necessary for a clear perception of objects, we would often be in danger of not distinguishing them, if we were not subjected to another law, to wit, that numerous impulses made at once, or in a quick succession to each other, increase our perceptions of objects. Thus, such sound as would not be heard on a mountain-top, will be distinctly heard in a wainscotted chamber.-----We feel much more clearly a tangible object when our finger is drawn along it than when applied with the same force, but by a single pressure upon it.-----We make repeated applications of odorous and sapid objects, when we wish to smell or taste accurately.-----The end of a burning stick appears much more luminous when quickly whirled in a circle than when at rest.

k. Whenever the uneasy sensation, *pain*, raised by the too strong application of objects, a sort of necessity is as it were imposed upon the mind to endeavour to get free from the injuring cause, by either withdrawing the grieved part of the body from it, as one who retires his hand when his finger is pricked

burn

burnt; or the injuring cause is endeavoured to be forced from the body, as a *tenesmus* excites the contraction which pushes acrid *fæces* out of the *rectum*. In both these operations, a convulsive contraction is immediately made in the lesed part, or in the neighbourhood of it; and if the irritation is very strong or permanent, the greater part of the nervous system becomes affected in that spasmodic or convulsive way.-----Is it this necessity which obliges the mind to exert herself in respiration, or in the action of the heart, when the lungs or heart are gorged with blood? or the *iris* to contract the pupil, when the eye is exposed to strong light? or sneezing to be performed when the nose is tickled? &c. ----- Will not a *stimulus* of any nerve more readily affect those with which it is any where connected than the other nerves of the body? - - - - May not this sympathy serve as a monitor of the mind rather to employ the organs furnished with nerves thus connected, to assist in freeing her of any uneasy sensation, than to make use of any other organs? - - - Will not this in some measure account for many salutary operations performed in the body before experience has taught us the functions of the organs performing them?

This *nifus* of the mind to free the body of what is in danger of being hurtful, may serve to explain the *phanomena* of a great many diseases, when we are acquainted with the distribution of the particular nerves; and from this we can understand the operation of

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medicines that stimulate ; and may learn how, by exciting a sharp, but momentary pain, we may free the body of another pain that would be more durable ; and that, by having it thus in our power to determine a flow of the liquor of the nerves to any particular part, for the benefit of that part, or the relief of any other diseased part, we can do considerable service by a right application of the proper medicines.

1. If a pain-giving cause is very violent or long continued, it destroys the organs either irrecoverably, or puts them so much out of order that they only gradually recover : People have been made blind or deaf for all their lives after a violent effect of light on their eyes, or of sound on their ears ; and we are frequently exposed to as much light and sound as to make us unfit to see or hear for a considerable time. I would explain this by a ligature put round the tender branch of an herb. This ligature drawn to a certain degree, may weaken the canals so as to be unfit for the circulation of the juices a good while, till they are gradually explicated and made firm by these juices : A stricter ligature would disorder the structure of the fibres so much, that the liquors could not recover them. The analogy is so plain, that it needs no commentary. ----- Thus the influence of a nerve tied with an artery in the operation of an aneurism may cease for some time, but be afterwards recovered.

67. 1. In applying the fluid of the nerves to the action of muscles, it was said, that

the natural or involuntary contraction of muscles was the *nifus* which the nervous fluid flowing constantly into the muscular fibres makes to distend these fibrils, by enlarging their transverse diameters and shortening their axes; and that voluntary contraction was owing to a greater quantity of that nervous liquor determined towards the muscle to be put in action, and poured with greater *momentum* into the muscular fibrils, by the power of the mind willing to make such a muscle to act, or obliged to do it by an irritating pain-giving cause (§ 66. k.)

2. Some object to this account of muscular motion, that if there is no outlet for the liquor supposed to be poured into muscular fibres, muscles would always be in a state of contraction, which they are not; and if there is a passage from the fibrils, the liquor would flow out as fast as it was thrown in; and therefore no distension of the fibres or contraction of the muscles could be made.

3. In answer to this objection, it is observed, that notwithstanding the evident outlet from the arteries into the veins, yet the arteries are distended by the *systole* of the heart, or any other cause increasing the *momentum* of the blood.

4. It has been also objected to § 1. that, if it was true, the volume of the muscle in contraction necessarily would be considerably increased by so much liquor poured into its fibrils; whereas it does not appear, by any

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experiment,



experiment, that the volume of a muscle is increased by its being put into action.

5. To this it has been answered, 1. That when the axes of muscular fibres are shortened, and their transverse diameters are enlarged, the capacities of their fibres, and consequently their volume, may not be changed, the diminution one way balancing the increase in the other. 2. That the spaces between the muscular fibres are sufficient to lodge these fibres when they swell, during the contraction of a muscle, without any addition to its bulk; and that it plainly appears that these spaces between the fibrils are thus occupied, by the compression which the larger vessels of muscles, which run in those spaces, suffer during the action of the muscle; it is so great as to drive the blood in the veins with a remarkable accelerated velocity.

6. Another objection to the action of muscles being owing to the influx of a fluid into their fibrils is, That muscular fibres are distractile, or capable of being stretched; and therefore, when a fluid is poured into their hollow fibrils, they would be stretched longitudinally, as well as have their transverse diameters increased; that is, a muscle would become longer, as well as thicker, when it is put into action; whereas it is certainly known that a muscle is shortened while it acts.

7. In answer to this, it has been remarked, That though muscular fibrils are distractile, yet they will not yield to, or be stretched by every force, however small, that might be applied to them. A cord that can be stretch-

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ed in length by the weight of a pound or two, would not yield in the least to an ounce or two; and it must likewise be observed, that gradually as any body is stretched, its resistance to the stretching force increases. A rope may be stretched to a certain length by a pound weight appended to it, which would require two pounds to stretch it very little further; and therefore the general observation of animal fibres being distractile, cannot be a reasonable objection to the account of muscular motion above mentioned, unless a proof is brought that the force which the liquid of the nerves must exert upon each fibre of a muscle, in order to make it act, is capable of distracting or stretching the fibres; which has not yet been attempted to be proved.——It would appear from the pain caused by too great an effort of muscles, especially in weak people, that muscular fibres can bear very little distraction without danger of a solution of continuity.

8. Muscles ceasing to act when their arteries are tied or cut, and being brought into motion by injecting liquors into the arteries even of a dead animal, has been mentioned as objections to the nervous influence causing their contractions.

To the first of these experiments it may be answered, That the tying or cutting of the nerves sooner produces the effect of making the contraction cease than stopping the influx of the arterious blood does; and it will be universally allowed, that the influx of blood

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into

into muscles is necessary for performing their functions right.

Whoever observes the motion which injecting water or any other liquor into the arteries of a dead animal, causes in its muscles, will not compare it to what contraction, whether voluntary or excited by irritation, he may see in a living one.

9. If muscular motion depends on the influx of the nervous liquid, the instantaneous contraction of a muscle, when the mind wills to make it act, will be easily understood from the nerves being always full of their liquor (§ 58. 66. a.)

10. If either the nerves of any muscle do not furnish a sufficient quantity of their liquor, or if the fibres of a muscle become too easily distractile, such a muscle will be unactive or paralytic.

11. If too great a quantity of the liquor of the nerves is determined to a muscle or muscles, by any cause which the mind cannot command, such muscle or muscles will be convulsed.

12. If the motion of the liquid of the nerves is not uniform, but by disease becomes irregular, an alternate relaxation and contraction of muscles may be the consequence. Hence trembling palsies, *chorea Sancti Viti*, &c. Hence also the convulsive tremors which animals have when they lose much blood.

13. Though the nerves may not furnish so much liquor as may be sufficient to make muscles contract with strength enough to overcome

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come the resistances to their actions, yet there may be a sufficient quantity of liquor in the nerves to allow the impressions of objects to be conveyed to the *sensorium*. This may be one cause of a member's being sometimes sensible after it cannot be moved.

14. Unless the liquor of the nerves acquires some energy in the brain, which we have no reason to think the circulation of the fluids in the vessels can give it, or unless it has other properties than what we can discover in it, or unless there is an agent regulating its *momentum* and course to different parts which we are not conscious of; if some of these, I say, do not obtain, the action of the heart continuing of equal force to propel our liquors, notwithstanding all the resistances that are to it, is not to be explained.

15. All muscles, but especially the heart, continue to contract in an irregular way, after they are cut away from the animal to whom they belonged; which may be owing to the liquors continuing to flow in the small vessels, and being powered irregularly into the muscular *fibrilla*.

16. It is said that a muscle cut out of the body continues some time to be capable of contraction; whereas by tying its arteries or nerves, while it is otherwise entire in the body, it loses its contracting power, which therefore does not depend on these organs, the arteries or nerves.

The loss of the power of acting when the arteries or nerves are tied while the muscle  
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is in the body, is denied by some who made the trial, and it might be expected that the motion of a muscle would be more conspicuous where there is no resistance to it, as is the case when it is cut away from all the parts it is connected with, than when its connection remains with parts resisting its contractile efforts.

17. After the heart, or any other muscle cut away from an animal, has ceased to contract, its contraction may again be restored, by breathing upon it, or pricking it with any sharp instrument. That heat or pricking should, by their *stimulus* (§ 66. k.) occasion contraction in a living creature, may be understood; but how they should have the same effect in a muscle separated from an animal, I know not.

68. Some have thought the *ganglions* of nerves (§ 18. 19. 20.) to be glandular, and to perform a secretion.—Others, from their firm texture, suppose them to be muscular, and to serve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of these opinions, they cannot be maintained.—Others would make them serve, 1. To divide a small nerve into many nerves, and by these means to increase the number of nervous branches. 2. To make nerves come conveniently by different directions to the parts to which they belong. 3. To reunite several small nervous fibres into one large nerve.—Since no proof is brought that these three things cannot be done without the interposition of a *ganglion*, but on the contrary, we see them performed where there

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are no *ganglions*, we must continue to acknowledge ignorance concerning the uses of these knots, the *ganglions*.

## Of the PARTICULAR NERVES.

**T**IS generally said, that there are forty pair of nerves in all; of which ten come out from the *encephalon*, and the other thirty have their origin from the *spinal marrow*.

Of the ten pair of nerves which come from the *encephalon*, the first is the *OLFACTORY*, which long had the name of the *mammillary processes* of the brain, because in the brutes, cows and sheep, which were most commonly dissected by the antients, the anterior ventricles of the brain are extended forewards upon these nerves, and adhere so firmly to them, that they seem to make the upper side of the nerves. Each of them being large, where it begins to be stretched out, and gradually becoming smaller as it approaches the cribriform bone, was imagined to resemble a nipple. Those who mistook the ventricles for part of the nerves, observing the cavity in them full of liquor, concluded, that these olfactory nerves served to convey the superfluous moisture of the brain to the holes of the ethmoid bone through which it passed into the nose. But in man, the ventricles of whose brain are not thus extended forewards, these nerves are small, long, and without any cavity,



ty, having their origin from the *corpora striata*, near the part where the internal carotid arteries are about to send off their branches to the different parts of the brain; and in their course under the anterior lobes of the brain, which have each a depression made for lodging them, the human olfactory nerves become larger, till they are extended to the cribriform bone, where they split into a great number of small filaments, to pass through the little holes in that bone; and being joined by a branch of the fifth pair of nerves, are spread on the membrane of the nose.

The tender structure and sudden expansion of these nerves on such a large surface, renders it impossible to trace them far; which has made some authors deny them to be nerves: But when we break the circumference of the *cribriform lamella*, and then gently raise it, we may see the distribution of the nerves some way on the membrane of the nose.

The contrivance of defending these long soft nerves from being too much pressed by the anterior lobes of the brain under which they lie is singular; because they have not only the prominent orbital processes of the frontal bone to support the brain on each side, with the veins going into the longitudinal *sinus*, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itself for them to lodge in. — Their splitting into many small branches before they enter the bones of the skull, is likewise peculiar to them, for generally the nerves come from the brain in disgregated filaments, and unite into cords while the

as they are going out at the holes of the bones. This contrivance is the best for answering the purpose they are designed for, of being the organ of smelling; for had they been expanded upon the membrane of the nose into a medullary web, such as the optic nerve forms, it would have been too sensible to bear the impressions of such objects as are applied to the nose; and a distribution in the more common way, of a cord sending off branches, would not have been equal enough for such an organ of sensation.

The 2d pair of nerves, the *OPTIC*, rising from the *thalami nervorum opticorum*, make a large curve outwards, and then run obliquely inwards and forewards, till they unite at the fore-part of the *fella turcica*; then soon divide, and each runs obliquely forewards and outwards to go out at its proper hole in the sphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the inside of the eye as far forewards as the *ciliary circle*, and is universally known by the name of *retina*.

Though the substance of this pair of nerves seems to be blended at the place where they are joined; yet observations of people whose optic nerves were not joined, and of others who were blind of one eye from a fault in the optic nerve, or in those who had one of their eyes taken out, make it appear, that there is no such intimate union of substance; the optic nerve of the affected side only being wasted, while the other was large and plump. And the same

same observations are contradictory to the doctrine of a decussation of all the nerves (§ 8.); for the disease could be traced from the affected eye to the origin of the nerve on the same side. In many fishes indeed, the doctrine of decussation is favoured; for their optic nerves plainly cross each other, without any union at the part where they are joined in men and most quadrupeds.

These people whose optic nerves were not joined, having neither seen objects double, nor turned their eyes different ways, is also a plain proof, that the conjunction of the optic nerves will not serve to account for either the uniform motions of our eyes, or our seeing objects single with two eyes, though it may be one cause of the remarkable sympathy of the one eye with the other in many diseases.

The *retina* of a recent eye, without any preparation, appears a very fine web, with some blood-vessels coming from its center to be distributed on it; but, after a good injection of the arteries that run in the substance of this nerve, as is common to other nerves, it is with difficulty that we can observe its nervous medullary substance.——The situation of these vessels in the central part of the optic nerve, the want of medullary fibres here, and the firmness of this nerve before it is expanded at its entry into the ball of the eye, may be the reason why we do not see such bodies, or parts of bodies, whose picture falls on this central part of the *retina*.——An inflammation in those arteries of the *retina*, which several fevers and an *ophthalmia* are generally attended with

with, may very well account for the tenderness in the eyes, and inability to bear the light, which people have in these diseases.—The over-distension of these vessels may likewise serve to account for the black spots observed on bright coloured bodies especially, and for that smoaky fog through which all objects are seen by people in some fevers.—If these vessels lose their tone, and remain preternaturally distended, no objects affect our retina, though the eye externally appears sound; or this may be one cause of an *amaurosis* or *gutta serena*.—From a partial distension of these vessels, or *paralysis* of a part of the retina, the central part, or the circumference, or any other part of objects, may be lost to one or both eyes.

The *THIRD PAIR* rise from the anterior part of the *processus annularis*, and piercing the *dura mater* a little before, and to a side of the ends of the posterior clinoid process of the sphenoid bone, run along the *receptacula*, or *cavernous sinuses*, at the side of the *ephippium*, to get out at the *foramina lacera*; after which each of them divides into branches, of which one, after forming a little *ganglion*, is distributed to the globe of the eye; the others are sent to the *musculus rectus* of the *palpebra*, and to the *attollens*, *adductor*, *deprimens*, and *obliquus minor* muscles of the eye-ball. These muscles being principal instruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the *motor oculi*.—I have frequently observed in convulsions the eye-lids widely opened, the *cornea*  
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turned upward and outwards, and the eye-balls sunk in the orbit; which well described the conjunct action of the muscles which this pair of nerves serves.—The distension of a considerable branch of the carotid, which passes over this nerve near its origin on each side, may possibly be the reason of the heaviness in the eye-lids and eyes, after drinking hard, or eating much.

The *FOURTH PAIR*, which are the smallest nerves of any, derive their origin from the back-part of the base of the *testes*; and, then making a long course on the side of the annular protuberance, enter the *dura mater* a little farther back, and more externally than the third part, to run also along the *receptacula*, to pass out at the *foramina lacera*, and to be entirely spent on the *musculi trochleares*, or superior oblique muscles of the eyes. These muscles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which several of our passions are expressed, the nerves that serve them have got the name of *PATHE TICI*.—Why these small nerves should be brought so far to this muscle, when it could have been supplied easily by the *motor oculi*, I know not.

The *FIFTH PAIR* are large nerves, rising from the annular processes where the medullary processes of the *cerebellum* join in the formation of that *tuber*, to enter the *dura mater* near the point of the petrous process of the temporal bones; and then sinking close by the *receptacula* at the sides of the  
*sella*



*fella turcia*, each becomes in appearance thicker, and goes out of the scull in three great branches.

The first branch of the fifth is the *O P H T H A L M I C*, which runs through the *foramen lacerum* to the orbit, having in its passage thither a connection with the sixth pair. It is afterwards distributed to the ball of the eye with the third; to the nose, along with the olfactory, which the branch of the fifth that passes through the *foramen orbitarium internum* joins, as was already mentioned in the description of the first pair. This ophthalmic branch likewise supplies the parts at the internal *canthus* of the orbit, the *glandula lacrymalis*, fat, membranes, muscles, and teguments of the eye-lids; its longest farthest extended branch passing through the *foramen superciliale* of the *os frontis*, to be distributed to the fore-head.

The small fibres which this first branch of the fifth and the third pair of nerves send to the eye-ball, being situated on the optic nerve, and, after piercing the sclerotic coat, running along the choroid coat on the outside of the *retina* in their course to the *uvea* or *iris*, may be a cause of the sympathy between the optic nerve and the *uvea*; by which we more readily acquire the habit of contracting the *iris*, and thereby lessen the pupil, when too strong light is excluded; and, on the contrary, enlarge the pupil, when the light is too faint.— This, with the sympathy which must arise from some of the nerves of the membrane of the

### 376 OF THE PARTICULAR NERVES.

nostrils, being derived from this first branch of the fifth pair of nerves, may also be the cause, why an irritation of the *retina*, by too strong light, may produce sneezing, as if a *stimulus* had been applied to the membrane of the nose itself; — why pressing the internal *canthus* of the orbit, sometimes stops sneezing; — why irritation of the nose or of the eye causes the eye lids to shut convulsively, and makes the tears to flow plentifully; and why medicines put into the nose, do often great service in diseases of the eyes. — In the megrim all the branches of the nerve discover themselves to be affected: for the forehead is racked with pain, the eye-ball is pained, and feels as if it was squeezed, the eye-lids shut convulsively, the tears trickle down, and an uneasy heat is felt in the nose. Hence we can understand where external medicines will have the best effect, when applied to remove this disease, to wit, to the membrane of the nose, and to the forehead; — why alternate pressure near the superciliary hole of the frontal bone, or sneezing, sometimes gives immediate relief in the megrim; — why the sight may be lost by an injury done to the *supra-orbital* branch; — how it may be restored by agitation of that branch of this nerve.

The second branch of the fifth pair of nerves may be called *MAXILLARIS SUPERIOR*, from its serving principally the parts of the upper jaw. It goes out at the round hole of the sphenoid bone, and sends immediately one branch into the channel on the top of the *antrum maxillare*; the membrane

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of which and the upper teeth are supplied by it in its passage. As this branch is about to go out at the *foramen orbitarium externum*, it sends a nerve through the substance of the *os maxillare* to come out at *Steno's duct*, to be distributed to the fore-part of the palate; and what remains of it escaping at the *external orbital* hole, divides into a great many branches, that supply the cheek, upper lip, and nostril.—The next considerable branch of the *superior maxillary* nerve, after giving branches which are reflected through the sixth hole of the *sphenoid* bone, to join the intercostal where it is passing through the scull with the carotid artery, and the *portio dura* of the seventh pair, as it passes through the *os petrosum*, is sent into the nose by the hole common to the palate and sphenoidal bone; and the remaining part of this nerve runs in the *palato-maxillaris* canal, giving off branches to the temples and pterygoid muscles, and comes at last into the palate to be lost.—Hence, the ach in the teeth of the upper jaw occasions a gnawing pain deep seated in the bones of the face, with swelling in the eye-lids, cheek, nose, and upper lip; and on the other hand, an inflammation in these parts, or a megrim, is often attended with sharp pain in the teeth.—Hence, an obstruction in the duct of the maxillary sinus, which obliges the liquor secreted there to find out a preternatural route for itself, may be occasioned by the pain of the teeth.—Hence, the upper lip often suffers when the palate or nose is ulcerated.

The third or *MAXILLARIS INFERIOR* branch of the fifth pair going out at the oval hole of the sphenoid bone, serves the muscles of the lower jaw, and the muscles situated between the *os hyoides* and jaw: All the salivary glands, the *amygdalæ*, and the external ear, have branches from it: It has a large branch lost in the tongue, and sends another through the canal in the substance of the lower jaw to serve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be lost in the chin and under lip.—Hence a convulsive contraction of the muscles of the lower jaw, or the mouth's being involuntarily shut, a great flow of spittle or salivation, a pain in the ear, especially in deglutition, and a swelling all about the throat, are natural consequences of a violent irritation of the nerves of the lower teeth in the toothach; and pain in the teeth and ear, is as natural a consequence of an *angina*.—Hence alternate pressure on the chin may sometimes relieve the violence of a toothach.—Hence destroying the nerves of a tooth by actual or potential cauteries, or pulling a carious tooth, so often removes immediately all these symptoms.—Hence no cure is to be found for some ulcers in the upper or lower jaw, but by drawing a tooth.—Hence in cancers of the upper lip, the salivary glands are in danger of being affected, or the disease may be occasioned to the lip by its beginning in the glands.—Perhaps the sympathy of the organs of tasting and smelling may

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in some measure depend on their both receiving nerves from the fifth pair.

The *SIXTH PAIR*, which is the smallest except the fourth, rises from the forepart of the *corpora pyramidalia*; and each entering the *dura mater* some way behind the posterior clinoid process of the sphenoid bone, has a long course below that membrane, and within the *receptaculum* at the side of the *sella turcica*, where it is immersed in the blood of the receptacle; but for what purpose I am ignorant. It goes afterwards out at the *foramen lacerum* into the orbit, to serve the abductor muscle of the eye.—A defect in this nerve may therefore be one cause of a *strabismus*.—In the passage of this nerve below the *dura mater*, it lies very contiguous to the internal carotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the sixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rises obtuse, to descend with the artery, and to form the beginning of the intercostal nerve, according to the common description; or, according to other authors, this nerve comes up from the great ganglion of the *intercostal*, to be joined to the sixth here.

The arguments for this latter opinion are, That, according to the common doctrine, this beginning of the *intercostal* nerve, as it is called, would rise in a manner not so ordinary in nerves. In the next place, it is observed, that the sixth pair is larger nearer to the orbit, than it is before it comes to the place where  
this



this nerve is said to go off; and therefore it is more probable, that it receives an addition there, rather than gives off a branch. *Lastly*, It is found, that upon cutting the *intercostal* nerves, of living animals, the eyes plainly were affected; they lost their bright water; the gum, or gore, as we call it, was separated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal *canthus*, came more over the eye; and the eye-ball itself was diminished.

To this it is answered, in defence of the more common doctrine, *1st*, That other branches of nerves go off in a reflected way, as well as this does, supposing it to be the beginning of the *intercostal*; and that the reflection would rather be greater, if it is thought to come up from the *intercostal* to the sixth. *2dly*, It is denied that this nerve is for ordinary thicker at its fore than its back-part; and if it was supposed to be thickest nearer to the orbit, the conclusion made above could not be drawn from this appearance, because other nerves enlarge sometimes where there is no addition made to them, as in the instance already mentioned of the trunk of the fifth pair while below the *dura mater*. *3dly*, The experiments on living animals shew indeed, that the eyes are affected upon cutting the *intercostal* nerve, but not in the way which might have been expected, if the *intercostal* had furnished such a share of the nerve that goes to the *abductor* muscle of the eye; for it might have been thought, that this muscle would have been so much weakened immediately upon cutting the *inter-*

*intercostal*, that its antagonist the *adductor* would have greatly prevailed over it, and have turned the eye strongly in towards the nose ; which is not said to be a consequence of this experiment. So that the arguments are still equivocal ; and more observations and experiments must be made, before it can be determined with certainty, whether the sixth pair gives or receives a branch here. In the mean time, I shall continue to speak about the origin of the *intercostal* with the generality of anatomists.

At this place where the *intercostal* begins, the fifth pair is contiguous and adherent to the sixth ; and it is generally said, that the ophthalmic branch of the fifth gives a branch or two to the beginning of the *intercostal*, or receives such from it. Others deny any such communication between them ; and those who affirm the communication confess, that in some subjects they could not see it. After examining the nerves here in a great many subjects, I cannot determine whether or not there are nervous filaments going from the one to the other. Sometimes I have thought that I traced them evidently ; at other times I observed that what I dissected for nervous filaments, was collapsed cellular substance ; and in all the subjects where I had pushed an injection successfully into the very small arteries, I could only observe a *plexus* of vessels connecting the one to the other. In any of these ways, however, there is as much connection as, we are assured from many experiments and observations on other nerves, is sufficient to make

make a very great sympathy among the nerves here.—Possibly the appearances in the eyes of dogs, whose intercostal nerves were cut, might be owing to this sympathy.

The *SEVENTH PAIR* comes out from the lateral part of the *annular process*, behind where the medullary process of the *cerebellum* are joined to that *tuber*; and each being accompanied with a larger artery than most other nerves, enters the *internal meatus auditorius*, where the two large bundles of fibres, of which it appeared to consist within the skull, soon separate from each other; one of them entering by several small holes into the *vestibule*, *cochlea*, and *semicircular canals*, is stretched across this inner *camera* of the ear in a very soft pulpy substance; and being never seen in the form of a firm cord, such as the other parts of this and most other nerves become, is called *PORTIO MOLLIS* of the auditory nerve.

The other part of this seventh pair passes through *Galen's foramen cecum*, or *Follopian aqueduct*, in its crooked passage by the side of the *tympanum*; in which passage, a nerve is sent from the lingual branch of the inferior maxillary nerve, along the outside of the *tuba Eustachiana*, and crosses the cavity of the *tympanum*, where it has the name of *chorda tympani*, is commonly said to be joined to it. The very acute angle which this nerve makes with the fifth, or the sudden violent reflection it would suffer on the supposition of its coming from the fifth to the seventh, appears unusual; whereas, if we suppose that it comes from the seventh

seventh to the fifth, its course would be more  
 in the ordinary way, and the *chorda tympani*  
 would be esteemed a branch of the seventh pair  
 going to join the fifth, the size of which is in-  
 creased by this acquisition. This smaller bundle  
 of the seventh gives branches to the muscles of  
 the *malleus*, and to the *dura mater*, while it  
 passes through the bony crooked canal, and at  
 last comes out in a firm chord named *POR-  
 TIO DURA*, at the end of this canal, be-  
 tween the *styloid* and *mastoid* processes of the  
 temporal bone, giving immediately filaments  
 to the little oblique muscles of the head and  
 to those that rise from the styloid process. It  
 then pierces through the parotid gland, and  
 divides into a great many branches, which are  
 dispersed in the muscles and teguments that  
 cover all the side of the upper part of the  
 neck, the whole face and *cranium*, as far back  
 as the temples, including a considerable part  
 of the external ear. Its branches having thus  
 a considerable connection with all the three  
 branches of the fifth pair, and with the second  
 cervical, occasion a considerable sympathy of  
 these nerves with it.—Hence, in the tooth-  
 ach, the pain is sometimes very little in the  
 affected tooth, compared to what it is all along  
 the side of the head and in the ear.—Hence  
 probably the relief of the toothach from  
 blisters applied behind or before the ear, or by  
 hot iron touching the *antihelix* of the ear.  
 —By this communication or connection pos-  
 sibly too it is, that a vibrating string held be-  
 tween one's teeth, gives a strong idea of  
 sound to the person who holds it, which no  
 body



body else can perceive.-----Perhaps too the distribution of this nerve occasions the head to be so quickly turned upon the impression of sound on our ears.

The *EIGHTH PAIR* of nerves rise from the lateral bases of the *corpora olivaria* in distributed fibres; and as they are entering the anterior internal part of the holes common to the *os occipitis* and *temporum*, each is joined by a nerve which ascends within the *dura mater* from the tenth of the head, the first, second and inferior cervical nerves; This every body knows has the name of the *NERVUS ACCESSORIUS*. When the two get out of the skull the *accessorius* separates from the eighth, and, descending obliquely outwards, passes through the *sterno-mastoideus* muscle, to which it gives branches, and afterwards terminates in the *trapezius* and *rhomboid* muscles of the *scapula*. In this course it is generally more or less joined by the second cervical nerve.-----Why this nerve, and several others which are distributed to muscles, are made to pierce through muscles, which they might have only passed near to, I do not know.

The large *eighth pair*, soon after its exit, gives nerves to the tongue, *larynx*, *pharynx*, and *ganglion* of the *intercostal* nerve, and being disjoined from the ninth and intercostal, to which it adheres closely some way, runs straight down the neck behind the internal jugular vein, and at the external side of the carotid artery. As it is about to enter the *thorax*, a large nerve goes off from the eighth

of each side : This branch of the right-side turns round from the fore to the back part of the subclavian artery, while the branch of the left-side turns round the great curve of the *aorta*, and both of them mounting up again at the side of the *œsophagus*, to which they give branches, are lost at last in the *larynx*. These are called the *RECURRENT* nerves, which we are desired to shun in the operation of *bronchotomy*, though their deep situation protects them sufficiently.-----The muscles of the *larynx* being in a good measure supplied with nerves from the recurrents, it is to be expected, that the cutting of them will greatly weaken the voice, though it will not be entirely lost, so long as the superior branches of the eighth pair are entire.-----Why the recurrent nerves rise so low from the eighth pair to go round a large artery, and to have such a long course upwards, I know not.

The eighth pair, above and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themselves, send off small nerves to the *pericardium*, and to join with the branches of the intercostal that are distributed to the heart ; but their size and situation are uncertain.

After these branches are sent off, the *par vagum* on each side descends behind the great branch of the *trachea*, and gives numerous filaments to the lungs, and some to the heart in going to the *œsophagus*. The one of the left-side running on the fore-part of the *œsophagus*, communicates by several branches with the right one in its descent to be distributed

buted to the stomach: The right one gets behind the *œsophagus*, where it splits and rejoins several times before it arrives at the stomach, to which it sends nerves; and then being joined by one or more branches from the left-trunk, they run towards the *cæliac* artery, there to join into the great *semilunar ganglion* formed by the two intercostals.

From the distribution of this *par vagum*, we may learn how tickling the *fauces* with a feather or any such substance, excites a *nausea* and inclination to vomit; . . . why coughing occasions vomiting, or vomiting raises a cough.

—Hence we see how the nervous *asthma* and the *tussis convulsiva*, chincough, are attended with a straitening of the *glottis*;—why food difficult to digest occasions the *asthma* to weakly people; and why *emetics* have frequently cured the *asthma* very speedily;—why an attempt to vomit is sometimes in danger of suffocating *asthmatic* people; . . . why the superior orifice of the stomach is so sensible, as to be looked on as the seat of the soul by some; . . . why people subject to distensions of the stomach, have so often the sensation of balls in their breasts and throats;—why the *globus hystericus* is so often attended with a violent strangulation at the *glottis*.

The *NINTH PAIR* of nerves comes from the inferior part of the *corpora pyramidalia*, to go out of the skull at their proper holes of the occipital bone. After their egress they adhere for some way firmly to the eighth and intercostal; and then sending a branch, that in many subjects is joined with

branches

branches of the first and second cervical nerves, to be distributed to the thyroid gland and muscles on the fore-part of the *trachea arteria*, the ninth is lost in the muscles and substance of the tongue. Some have thought this nerve, and others have esteemed the third branch of the fifth pair of nerves, to be the proper gustatory nerve. I know no observation or experiments to prove either opinion, or to assure us, that both nerves do not serve for tasting and for the motion of the tongue.——May not the distribution of this nerve to the muscles below, as well as above the *os hyoides*, contribute to their acting more uniformly in depressing the lower jaw or head?

The *TENTH PAIR* rises in separate threads from the sides of the *spinal marrow*, to go out between the *os occipitis* and first *vertebra* of the neck. After each of them has given branches to the great ganglion of the intercostal, 8th, 9th, and 1st cervical nerves, it is distributed to the streight, oblique, and some of the extensor muscles of the head. Whether the name of the tenth of the head, or of the first vertebral, ought to be given to this pair of nerves, is of no such consequence as to deserve a debate, tho' it has some of the marks of the spinal nerves, to wit, its being formed of filaments proceeding from both the fore and back part of the *medulla*, and a little *ganglion* being formed where these filaments meet.

In the description of the sixth pair, I followed the usual way of speaking among anatomists, and called that the beginning of the in-



intercostal nerve which comes out of the scull; and therefore shall here subjoin a cursory description of this Aerve; notwithstanding its much larger part is composed of nerves coming out from the *spinal medulla*. There is no greater incongruity in point of method to say, that the nerve we are describing receives additions from others that have not been described, than it is to repeat in the description of a great many nerves, that each of them gives branches to form a nerve which we are ignorant of; which is all the difference between describing the intercostal before or after the spinal nerves.

The branch reflected from the sixth pair, joined possibly by some filaments of the *ophthalmic* branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the *temporal bone*, where the little nerve is very soft and pappy, and in several subjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its superior maxillary branch, before it comes out of the scull. May the compression of this nerve by the carotid artery when stretched during the *systole*, contribute to the *dilatation* of the *vein*? As soon as the nerve escapes out of this bony canal, it is connected a little way with the eighth and ninth; then separating from these, after seeming to receive additional nerves from them, it furnishes a large *ganglion*, into which branches from the tenth of the head, and from the first and second cervical, enter. From this *ganglion* the nerves come out again small to run

down

down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muscles that bend the head and neck. As the *intercostal* is about to enter the *thorax*, it forms another ganglion; from which nerves are sent to the *trachea* and to the heart; these designed for the heart joining with the branches of the eighth, and most of them passing between the two great arteries and the auricles, to the substance of that muscle. The *intercostal* after this consisting of two branches, one going behind, and the other running over the fore-part of the *subclavian artery*, forms a new ganglion where the two branches unite below that artery, and then descending along the sides of the *vertebrae* of the *thorax*, receives branches from each of the dorsal nerves; which branches appearing to come out between the ribs, have given the name of *intercostal* to the whole nerve. Where the addition is made to it from the fifth dorsal nerve, a branch goes off obliquely forwards; which being joined by such branches from the sixth, seventh, eighth, and ninth dorsal, an anterior trunk is formed, and passes between the fibres of the *appendix musculosa* of the diaphragm, to form, along with the other *intercostal* and the branches of the eighth pair, a large semilunar ganglion, situated between the *cæliac* and *superior mesenteric* arteries; the roots of which are as it were involved in a sort of nervous net-work of this ganglion, from which a great number of very small nervous threads run out to be extended on the surface of all the branches of

those two arteries, so as to be easily seen when any of the arteries are stretched, but not to be raised from them by dissection; and thus the *liver, gall-bladder, duodenum, pancreas, spleen, jejunum, ilium*, and a large share of the *colon*, have their nerves sent from this great *solar ganglion* or *plexus*.---- May the peristaltic motion of the intestines depend in some measure on the passage of the intercostal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the *aorta*, meet with other nerves sent from the posterior trunk of the intercostal, which continues its course along the sides of the *vertebrae*, they supply the *glandulae renales*, kidneys, and *testes* in men, or *ovaria* in women; and then they form a network upon the inferior mesenteric artery where the nerves of the two sides meet, and accompany the branches of this artery to the part of the *colon* that lies in the left side of the belly, and to the *rectum*, as far down as to the lower part of the *pelvis*.

The intercostal continuing down by the side of the *vertebrae* of the loins, is joined by nerves coming from between these *vertebrae*, and sends nerves to the organs of generation and others in the *pelvis*, being even joined with those that are sent to the inferior extremities.

The almost universal connection and communication which this nerve has with the other nerves of the body, may lead us to understand the following, and a great many more *phenomena*:—Why tickling the nose causes sneezing.—Why the too great quantity of bile in the *cholera* occasions vomiting as well as purging.

purging—Why people vomit in colics, in inflammations, or other irritations of the liver, or of the ducts going from it and the gall-bladder.——Why a stone in the kidneys, or ureters, or any other cause irritating those organs, should so much more frequently bring on vomiting and other disorders of the stomach, than the stone, or any other stimulating cause in the bladder does.——Why vomiting is a symptom of danger after child-birth, lithotomy, and other operations on the parts in the *pelvis*.——Why the obstructions of the *menfes* are capable of occasioning strangulations, belching, colics, stomach-aches, and even convulsions in the extremities.——Why vesicatories, applied from the ears to the clavicles of children labouring under the *tussis convulsiva*, are frequently of great service.——Why worms in the stomach or guts excite an itching in the nose, or grinding of the teeth.——Why irritations in the bowels or the belly occasion sometimes universal convulsions of the body.

The *spinal* nerves rise generally by a number of disgregated fibres from both the fore and back part of the *medulla spinalis*, and soon after form a little knot or ganglion, where they acquire strong coats, and are extended into firm cords. They are distinguished by numbers, according to the *vertebra* from between which they come out; the superior of the two bones forming the hole through which they pass, being the one from which the number is applied to each nerve. There are generally said to be *thirty pair* of them; seven of which come out between the *vertebra*



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*vertebra* of the neck, twelve between those of the back, five between those of the loins, and six from the *false vertebra*.

The *FIRST CERVICAL* pair of nerves comes out between the first and second *vertebra* of the neck; and having given branches to join with the tenth pair of the head, the second cervical and intercostal, and to serve the muscles that bend the neck, it sends its largest branches backwards to the extensor muscles of the head and neck; some of which piercing through these muscles, run up on the *occiput* to be lost in the teguments here; and many fibres of it advance so far forward as to be connected with the *fibrils* of the first branch of the fifth pair of the head, and of the *portio dura* of the *auditory nerve*.—

Hence possibly it is that a *clavus hyssericus* changes suddenly sometimes from the forehead to a violent pain and spasm in the back-part of the head and neck.

The *SECOND CERVICAL* is soon joined by some branches to the ninth of the head and intercostal, and to the first and third of the neck; then has a large branch that comes out at the exterior edge of the *sterno-mastoideus* muscle, where it joins with the *accessorius* of the eighth pair; and is afterwards distributed to the *platysma myoides*, teguments of the side of the neck and head, parotid gland, and external ear, being connected to the *portio dura* of the *auditory nerve*, and to the first cervical. The remainder of this second cervical is spent on the *levator scapulae* and the extensors of the neck and head. Generally

nerally a large branch is here sent off to join the *accessorius* of the eighth pair, near the superior angle of the *scapula*.

To the irritation of the branches of this nerve it probably is, that, in an inflammation of the parotid gland, the neck is pained so far down as the clavicle, the head is drawn towards the shoulder of the affected side, and the chin is turned to the other side.——In opening the external jugular vein, no operator can promise not to touch some of the cutaneous branches of this nerve with the lancet; which occasions a sharp pricking pain in the mean time, and a numbness of the skin near the orifice for some time after.

The *THIRD PAIR* of the neck passes out between the third and fourth cervical vertebrae; having immediately a communication with the second, and sending down a branch, which being joined by a branch from the fourth cervical, forms the *PHRENIC* nerve. This descending enters the *thorax* between the subclavian vein and artery; and then being received into a groove formed for it in the *pericardium*, it has its course along this *capsula* of the heart, till it is lost in the middle part of the diaphragm. The right phrenic has a straight course; but the left one is obliged to make a considerable turn outwards to go over the prominent part of the *pericardium*, where the point of the heart is lodged. Hence in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the stomach.—The middle of the diaphragm scarce could have been supplied

plied by any other nerve which could have had such a straight course as the *phrenic* has. If the subclavian artery and vein have any effect upon this nerve, I do not know it.

The other branches of the third cervical nerve are distributed to the muscles and teguments at the lower part of the neck and top of the shoulder. No wonder then that an inflammation of the liver or spleen, an abscess in the lungs adhering to the diaphragm, or any other cause capable of irritating the diaphragm, should be attended with a sharp pain on the top of the shoulder, as well as wounds, ulcers, &c. of this muscle itself.—If the irritation of this muscle is very violent, it may occasion that convulsive contraction of the diaphragm which is called an *hiccough*; and therefore an hiccough in an inflammation of the liver has been justly declared to be an ill symptom.

An irritation of the thoracic nerves which produces sneezing, may sometimes free the phrenic nerves from any spasm they occasion; so that sneezing sometimes takes away the hiccough; and a derivation of the fluid of the nerves any other way may do the same thing: Or the hiccough may also be sometimes cured, by drawing up into the nose the smoke of burning paper or other acrid fumes, swallowing pungent or aromatic medicines, and by a surprize, or any other strong application of the mind in thinking, or in distinguishing objects: Or, when all these have failed, it has been put away by the brisk stimulus of a blistering plaister applied to the back.

The

The **FOURTH CERVICAL** nerve, after sending off that branch which joins with the third to form the phrenic, and bestowing twigs on the muscles and glands of the neck, runs to the arm-pit, where it meets with the **FIFTH, SIXTH, and SEVENTH** cervicals, and **FIRST DORSAL**, that escape in the interstices of the *musculi scaleni*, to come at the arm-pit, where they join, separate, and rejoin, in a way scarce to be rightly expressed in words; and, after giving several considerable nerves to the muscles and teguments which cover the *thorax*, they divide into several branches, to be distributed to all the parts of the superior extremity. Seven of these branches I shall describe under particular names:

1. **SCAPULARIS** runs straight to the *cavitas semilunata* of the upper *costa* of the *scapula*, which is a hole in the recent subject by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muscles of the *scapula*. When it has passed this hole, it supplies the *supra spinatus* muscle; and then descending at the anterior root of the *spine* of the *scapula*, it is lost in the other muscles that lie on the *dorsum* of that bone.

2. **ARTICULARIS** sinks downwards at the *axilla*, to get below the neck of the head of the *os humeri*, and to mount again at the back-part of it; so that it almost surrounds the articulation, and is distributed to the muscles that draw the arm back, and to those that raise it up.

3. **CUT A.**



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3. *CUTANEUS* runs down the fore-part of the arm near the skin, to which it gives off branches; and then divides on the inside of the fore-arm into several nerves, which supply the teguments there, and on the palm of the hand. . . . In opening the basilic vein of the arm, at the ordinary place, the same symptoms are sometimes produced as in opening the external jugular vein, and from a like cause, to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. *MUSCULO-CUTANEUS*, or *perforans Casseri*, passes through the *coracobrachialis* muscle; and, after supplying the *biceps flexor cubiti* and *brachioæus internus*, passes behind the tendon of the *biceps*, and over the cephalic vein, to be bestowed on the teguments on the outside of the fore-arm and back of the hand. . . . This nerve is sometimes hurt in opening the cephalic vein, and causes pain and numbness for a short time.

5. *MUSCULARIS* has a spiral course from the *axilla*, under the *os humeri*, and backward to the external part of that bone, supplying by the way the extensor muscles of the fore-arm, to which it runs between the two *brachioæi* muscles, and within the *supinator radii longus*. — At the upper-part of the fore-arm, it sends off a branch, which accompanies the *supinator longus* till it comes near the wrist, where it passes obliquely over the *radius*, to be lost in the back of the hand and fingers. . . . The principal part of this nerve pierces through the *supinator radii brevis*, to  
serve

serve the muscles that extend the hand and fingers, whose actions are not injured when the *supinator* acts.

6. *ULNARIS* is extended along the inside of the arm, to give nerves to the muscles that extend the fore-arm and to the teguments of the elbow: Towards the lower part of the arm, it slants a little backward to come at the groove behind the internal condyle of the *os humeri*, through which it runs to the *ulna*: In its course along this bone, it serves the neighbouring muscles and teguments; and as it comes near the wrist, it detaches a branch obliquely over the *ulna* to the back of the hand, to be lost in the convex part of several fingers. The larger part of the nerve goes straight forward to the internal side of the *os pisiforme* of the wrist; where it sends off a branch which sinks under the large tendons in the palm, to go cross to the other side of the wrist, serving the *musculi lumbricales* and *interossei*, and at last terminating in the short muscles of the thumb and fore-finger. What remains of the ulnar nerve after supplying the short muscles of the little-finger, divides into three branches; whereof two are extended along the sides of the sheath of the tendons of the flexors of the little-finger, to furnish the concave side of that finger; and the third branch is disposed in the same way upon the side of the ring-finger next to the little-finger.

When we lean or press on the internal condyle of the *os humeri*, the numbness and

prickling we frequently feel, point out the course of this nerve. I have seen a weakness and atrophy in the parts which I mentioned this nerve to be sent to, after a wound in the internal lower part of the arm.

7. *RADIALIS* accompanies the humeral artery to the bending of the elbow, serving the flexors of the cubit in its way; then passing through the *pronator radii teres* muscle, it gives nerves to the muscles on the fore-part of the fore-arm, and continues its course near to the *radius*, bestowing branches on the circumjacent muscles. Near the wrist, it sometimes gives off a nerve which is distributed to the back of the hand, and the convex part of the thumb and several of the fingers, instead of the branch of the muscular. The larger part of this nerve, passing behind the annular ligament of the wrist, gives nerves to the short muscles of the thumb; and afterwards sends a branch along each side of the sheath of the tendons of the flexors of the thumb, fore-finger, mid-finger, and one branch to the side of the ring finger, next to the middle one, to be lost on the concave side of those fingers.

Though the *radial* nerve passes through the *pronator* muscle, and the *muscular* nerve seems to be still more unfavourably placed within the *supinator brevis*; yet the action of these muscles don't seem to have any effect in hindering the influence of these nerves, for the fingers or hand can be bended while pronation is performing vigorously, and they can be extended while supination is exercised.

The

The manner of the going off of these nerves of the fingers, both from the *ulnar* and *radial*, is, that a single branch is sent from the trunk to the side of the thumb and little-finger farthest from the other fingers; and all the rest are supplied by a trunk of a nerve, which splits into two some way before it comes as far as the end of the *metacarpus*, to run along the sides of different fingers that are nearest to each other.

It might have been observed, that, in describing the posterior branches of the *ulnar* and *muscular nerve*, I did not mention the particular fingers, to the convex part of which they are distributed. My reason for this omission is, the uncertainty of their distribution; for though sometimes these posterior branches go to the same fingers, to the concave part of which the anterior branches of the *ulnar* and *radial* are sent, yet frequently they are distributed otherwise.

The situation of these brachial nerves in the *axilla*, may let us see, how a weakness and atrophy may be brought on the arms by long continued pressure of crutches, or such other hard substances on this part; and the course of them from the neck to the arm may teach us, how much better effects vesicatories, or stimulating nervous medicines, would have, when applied to the skin, covering the transverse processes of the *vertebrae* of the neck, or at the *axilla*, than when they are put between the shoulders, or upon the spinal processes, in convulsions or palsies of the superior extremities, where a *stimulus* is required.



The *TWELVE DORSAL* nerves of each side, as soon as they escape from between the *vertebra*, send a branch forward to join the intercostal, by which a communication is made among them all; and they soon likewise give branches backwards to the muscles that raise the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the *thorax*, between the internal and external intercostal muscles, giving off branches in their course to the muscles and teguments of the *thorax*.

The *FIRST* dorsal, as was already observed, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercostal, which come down to the *thorax*, form a considerable ganglion with it.

The *SIX* lower dorsal nerves give branches to the diaphragm and abdominal muscles.

The *TWELFTH* joins with the first lumbar, and bestows nerves on the *musculus quadratus lumborum* and *iliacus internus*.

May not the communications of all these nerves be one reason, why the parts they serve act so uniformly and conjunctly in respiration, and conspire together in the convulsive motions of coughing, sneezing, &c.?  
—The twitching spasms that happen sometimes in different parts of the muscles of the *abdomen*, by an irritation on the branches of the lower dorsal nerves, are in danger of occasioning a mistake in practice, by their resemblance to the colick, *nephritis*, &c.——

The

The communications of these lower ones with the intercostals, may serve to explain the violent effort of the abdominal muscles in a *tetanus* and in child bearing.

As the intercostal is larger in the *thorax* than any where else, and seems to diminish gradually as it ascends and descends, there is cause to suspect that this is the trunk from which the superior and inferior pairs are sent as branches.

The *FIVE LUMBAR* nerves on each side communicate with the intercostal and with each other, and give branches backwards to the loins.

The *FIRST* communicates with the last dorsal, sends branches to the abdominal muscles, to the *psoas* and *iliacus*, and to the teguments and muscles on the fore-part of the thigh; while its principal branch joins with the other nerves, to form the crural nerve.

The *SECOND LUMBAR* nerve passes through the *psoas muscle*, and is distributed nearly in the same way as the former: as is also the *THIRD*.

Branches of the *second, third, and fourth*, make up one trunk, which runs along the fore-part of the *pelvis*; and passing in the notch at the fore-part of the great hole common to the *os pubis* and *ischium*, is sent on the *adductor* muscles, and on the teguments on the inside of the thigh. This nerve is called the *OBTURATOR*, or *POSTERIOR CRURAL NERVE*.

By united branches from the *first, second, third, and fourth* lumbar nerves, a nerve is

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formed that runs along the *psoas* muscle, to escape with the external iliac vessels out of the *abdomen*, below the tendinous arcade of the external oblique muscle. This nerve, which is named the *ANTERIOR CRURAL*, is distributed principally to the muscles and teguments on the fore part of the thigh. A branch, however, of this nerve runs down the inside of the leg to the upper part of the foot, keeping near to the *vena saphæna*; in opening of which with a lancet at the ankle, the nerve is sometimes hurt, and occasions sharp pain at the time of the operation, and numbness afterwards.

The remainder of the fourth lumbar and the fifth join in composing the largest nerve of the body; which is soon to be described.

Whoever attends to the course of these lumbar nerves, and of the spermatic vessels and nerves upon the *psoas* muscle, with the oblique passage of the *ureter* over that muscle, will not be surpris'd, that when a stone is passing in this canal, or even when it is inflamed, the trunk of the body cannot be rais'd erect, without great pain; or that the skin of the thigh becomes less sensible, and the thigh is drawn foreward, and that the testicle often swells and is drawn convulsively towards the ring of the abdominal muscles.

The *SIXTH PAIR* of the false *VERTEBRÆ* consist each of small posterior branches sent to the hips, and of large anterior branches.

The *first, second, and third*, after coming through the three upper holes in the forepart

part of the *os sacrum*, join together with the fourth and fifth of the loins, to form the largest nerve of the body, which is well known by the name of *SCIATIC* or *ISCHIATIC* nerve: This, after sending large nerves to the different parts of the *pelvis*, and to the external parts of generation and the *podex*, as also to the muscles of the hips, passes behind the great *tuber* of the *os ischium*, and then over the *quadrigemini* muscles to run down near to the bone of the thigh at its back part, giving off nerves to the neighbouring muscles and teguments. Some way above the ham, where it has the name of the *popliteus* nerve, it sends off a large branch that passes over the *fibula*, and sinking in among the muscles on the anterior external part of the leg, runs down to the foot, to be lost in the upper part of the larger toes, supplying the neighbouring muscles and teguments every where in its passage. The larger branch of the *sciatic*, after giving branches to the muscles and teguments about the ham and knee, and sending a large cutaneous nerve down the calf of the leg, to be lost at last on the outside of the foot and upper part of the lesser toes, sinks below the *gemellus* muscle, and distributes nerves to the muscles on the back of the leg; among which it continues its course, till passing behind the internal *malleolus*, and in the internal hollow of the *os calcis*, it divides into the two plantar nerves: The internal of which is distributed to the toes in the same manner that the *radial* nerve of the hand serves the concave side of the thumb and fingers; and the external *plan-*  
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*tar* is divided and distributed to the sole of the foot and toes, nearly as the *ulnar* nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of these nerves, that serve the *inferior extremities*, pierce through muscles.

By applying what was said of the nerves in general to the particular distribution of the nerves of the *inferior extremities*, we may see how people with fractured legs, especially where there are splinters, should be subject to convulsive startings of the fractured member. - - - Why, upon tying the blood-vessels in an amputation of the leg, the patients should sometimes complain of violent pain in their toes; - - - why such patients should also be troubled with startings; - - - why, for a considerable time after the amputation of the diseased limb, when the suppuration is well advanced, they should complain of pain in the fore which occasioned the amputation.

The *FOURTH*, which, with the two following, is much smaller than the three superior, soon is lost in the *vesica urinaria* and *intestinum rectum*.

The *FIFTH* comes forward between the extremity of the *os sacrum* and *coccygis*, to be distributed principally to the *levator ani*.

The *SIXTH*, which some think to be only a production of the *dura mater*, advances forward below the broad shoulders of the first bone of the *os coccygis*, and is lost in the *sphincter ani* and teguments covering it.

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The branches of the four last cervical nerves, and of the first dorsal, which are bestowed on the *superior extremities*, and the two crurals, with the sciatic, which are distributed to the *inferior extremities*, are much larger proportionally to the parts they serve, than the nerves of the trunk of the body, and especially of the *viscera*, are; and for a very good reason, that in the most common necessary actions of life, a sufficient quantity of fluid, on which the influence of nerves seems to depend, may be supplied to the muscles there, which are obliged to perform more frequent and violent contractions than any other parts do.

----- The size of the nerves of the *inferior extremities* seems larger proportionally than in the *superior extremities*; the *inferior extremities* having the weight of the whole body to sustain, and that frequently at a great disadvantage. — What the effect is of the nerves here being injured, we see daily, when people happen, by sitting wrong, to compress the sciatic nerve, they are incapable for some time after to support themselves on the affected *extremity*: And this is still more remarkable in the *sciatic* or *hip-gout*, in which the member is not only weakened, but gradually shrivels and wastes.

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D E S C R I P T I O N

Of the HUMAN

LACTEAL SAC AND DUCT.

THE *receptaculum chyli* of *Pecquet*, or *saccus lacteus* of *Van Horne*, is a membranous somewhat pyriform bag, two thirds of an inch long, one third of an inch over in its largest part when collapsed; situated on the first *vertebra* of the loins to the right of the *aorta*, a little higher than the right emulgent artery, behind the right inferior muscle of the diaphragm: it is formed by the union of three tubes, one from under the *aorta*, the second from the interstice of the *aorta* and *cava*, the third from under the emulgents of the right side. The *lacteal sac*, becoming gradually smaller towards its upper part, is contracted into a slender membranous pipe, of about a  
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line diameter, which is generally named the *THORACIC DUCT*. This passes betwixt the muscular *appendices* or inferior muscles of the diaphragm, on the right of, and somewhat behind the *aorta*; then, being lodged in the cellular substance behind the *pleura*, it mounts between the *aorta* and the *vena azygos* as far as the fifth *vertebra* of the *thorax*, where it is hid by the *azygos*, as this vein rises forwards to join the descending or superior *cava*; after which the duct passes obliquely over to the left side behind the *œsophagus*, *aorta descendens*, and the great curvature of the *aorta*, until it reaches the left carotid artery; behind which, on the left side of the *œsophagus*, it runs to the interstice of the first and second *vertebra* of the *thorax*, where it begins to separate from the carotid, stretching farther towards the left internal jugular vein by a circular turn, whose convex part is uppermost. At the top of this arch it splits into two for a line and an half; the superior branch receiving into it a large lymphatic vessel from the cervical glands. This lymphatic appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its course towards the internal jugular vein, behind which it descends, and, immediately at the left side of the insertion of this vein, enters the superior posterior part of the left subclavian vein, whose internal membrane duplicated, forms a semilunar valve that is convex externally, and covers two thirds of the orifice of the duct; immediately below this orifice, a cervical vein from

from the *musculi scaleni* enters the subclavian.

The coats of the *sac* and *duct* are thin transparent membranes; from the inside of which, in the duct, small semilunar valves are produced, most commonly in pairs; which are so situated as to allow the passage of liquors upwards, but oppose their return in an opposite course. The number of these is generally ten or twelve.

This is the most simple and common course, situation, and structure of the *receptaculum chyli* and *thoracic duct*; but having had occasion to observe a variety in these parts, of different subjects, I shall set down the most remarkable of them.

The sac is sometimes situated lower down than in the former description; is not always of the same dimensions; is not composed of the same number of ducts; and frequently appears to consist of several small cells or ducts, instead of being one simple cavity.

The diameter of the duct is various in most bodies, and is seldom uniform in the same subject; but frequently sudden enlargements or *sacculi* of it are observable. . . . . The divisions which authors mention of this duct are very uncertain. I have seen it divided into two, whereof one branch climbed over the forepart of the *aorta* at the eighth *vertebra* of the *thorax*, and at the fifth slipped behind that artery, to join the other branch which continued in the ordinary course. — The precise *vertebra*, where it begins to turn to the left side, is also uncertain. — Frequently it does not

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#### 410 OF THE LACTEAL SAC AND DUCT.

split at its superior arch ; in which case a large sac is found near its aperture into the subclavian vein.—Generally it has but one orifice ; though I have seen two in one body, and three in another : Nay, sometimes it divides into two, under the curvature of the great artery ; one goes to the right, another to the left subclavian vein ; and I have found this duct discharging itself entirely into the right subclavian.—The lymphatic vessel which enters its superior arch, is often sent from the *thyroid* gland.

Whether is not the situation of the *receptaculum chyli* so much nearer the muscular *appendices* of the diaphragm in men than in brutes, designed to supply the disadvantageous course the chyle must otherwise have in our erect posture ?

Does not the descent of the end of the duct to the subclavian vein, and the opening of the lymphatic into the top of the arch, contribute to the ready admission of the chyle into that vein ?

F I N I S.

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